In this Issue
AIR ROLE ADVANCED IN NEW ARMY

APRIL 1942

AVIATION

The Oldest American Aeronautical Magazine

McGraw-Hill Publishing Company, Inc.

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Wildcats in Action

In a recent engagement between Japanese land-based aircraft and Grumman Wildcats carrier-based fighters, a total of ten Japanese fighters and three bombers were destroyed without a single loss of our own planes." —Secretary Knox. These Wildcats, like all other Grumman F4F's in Navy service, are powered by Pratt & Whitney Twin Wasps.

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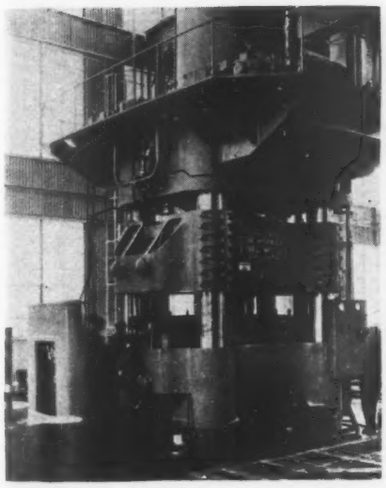

Indicative of the current phase of the productive effort of the aviation industry is this giant 5000-ton press built by the Hydraulic Press Company for aircraft production. The rubber press pad alone, manufactured by B. F. Goodrich, weighs 4000 pounds.

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McGRAW-HILL PUBLISHING CO., INC.

Publication office, 99-129 North Broadway, Albany, N. Y. Editorial and executive offices, 330 West 42nd Street, New York, N. Y. Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta.

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Published monthly, price 50c a copy, 50c in Canada. Allow at least 10 days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York. Subscription rates—United States, Mexico, and Central American Countries, $3.00 a year, $4.00 for two years, $5.00 for three years. Canada, $3.50 for one year, $5.00 for two years, $6.00 for three years, payable in Canadian currency at par. Great Britain and British Possessions 30 shillings per year, 60 shillings for three years. All other countries, $5.00 a year, $10.00 for three years. Entered as second-class matter, September 3, 1936, at the Post Office, Albany, New York, under the Act of March 3, 1879. Volume 41, Number 4. Printed in U. S. A. Cable address: "McGrawhill New York."

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AVIATION

REGULAR EDITION

APRIL, 1942

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Pioneer Precision

faithfully indicates the "ups and downs" of flight

Rate of climb (or of descent) is something a man needs to know when he's flying a modern high-performance airplane. And he wants to be able to ascertain it accurately in one swift glance. That is why pilots esteem the Pioneer Sensitive Rate-of-Climb Indicator so highly. It is the most advanced instrument yet developed for the purpose. It is free of certain service and maintenance requirements of older instruments and is most reliable . . . in short, a true Pioneer Instrument. It aids appreciably in our nation's One Big Job—to "Keep 'em flying."

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★ IN THIS ISSUE ★ ★ ★ ★ ★ ★ ★ ★

FINANCIAL DEVELOPMENTS loomed large in the aviation picture during the last month. In a discussion of the significance of these developments the lead editorial (page 51) points out that a number of aviation manufacturers are setting aside reserves against the expenses of their inevitable transition from war to peace time operations. We believe that this practice if generally followed will simplify the process of readjustment of the industry after the war.

AVIATION's War Communique No. 4 continues our running commentary on air power in this war. Biggest development was the complete reorganization of the U. S. Army giving air power equal status with the ground forces, and the shakeup in the Navy command which placed a flying admiral at the head of operations.

GOOD NEIGHBORS

The way in which airlines are cementing hemispherical relations is described in a story by Leonard E. Read, who

Harold H. Warden

realistically points out that the strength of our bonds with our neighboring republics to the south after the war effort is ended will depend on economic rather than political consideration (page 54).

Continuing our series of articles designed to assist management of aviation production plants, there begins on page 56 an article which demonstrates the importance of improved health education, recreational facilities, sanitation, and nutrition in any program designed to boost morale.

Adding to its collection of photographs and silhouettes of enemy planes, many of which have not been presented previously to the public, AVIATION shows three full pages of German aircraft (pages 57, 58, and 59).

AIDS TO PRODUCTION

The Manufacturing Section of this issue leads off with a complete and authoritative article by Dr. D. S. Frederick of the Röhm & Haas Co. on correct methods of **Plexiglas installation (page 62)**. Illustrations and sketches, mostly in color, augment the text. It should prove of invaluable assistance to design engineers and production men in achieving maximum efficiency in installations of transparent plastics.

Designing Propellers to Meet Performance Requirements (page 70), by Harold H. Warden of Curtiss-Wright's Propeller Division, describes those factors that are considered in coordinating propeller design with airplane design.

The complete sequence of machining operations in the production of struts for the Lockheed P-38 Interceptor-Pursuit is described in an article by W. G. Wood, (page 74).

The first of a series of articles by Walter C. Clayton, chief engineer of the Curtiss-Wright Technical Institute, on design charts for tubular members begins on page 80. Design engineers will welcome these short cuts for determining wall thicknesses of tubes subjected to bending to yield a desired margin of safety. Later articles will deal with tubes subjected to shear and torsion.

G. E. Cassidy of General Electric's Industrial Engineering Division presents a practical method for salvaging part of the enormous energy generated in testing aircraft engines (page 88).

Part I of an article describing the method by which the strength of riveted and bolted joints is calculated begins on page 91. This series has been prepared by Wayne A. McGowan, senior

G. E. Cassidy

Frank T. Courtney

stress analyst of Consolidated Aircraft.

How good maintenance men are being turned out in volume for the military services and commercial operations is described in a story on the Roosevelt Aviation School (page 153).

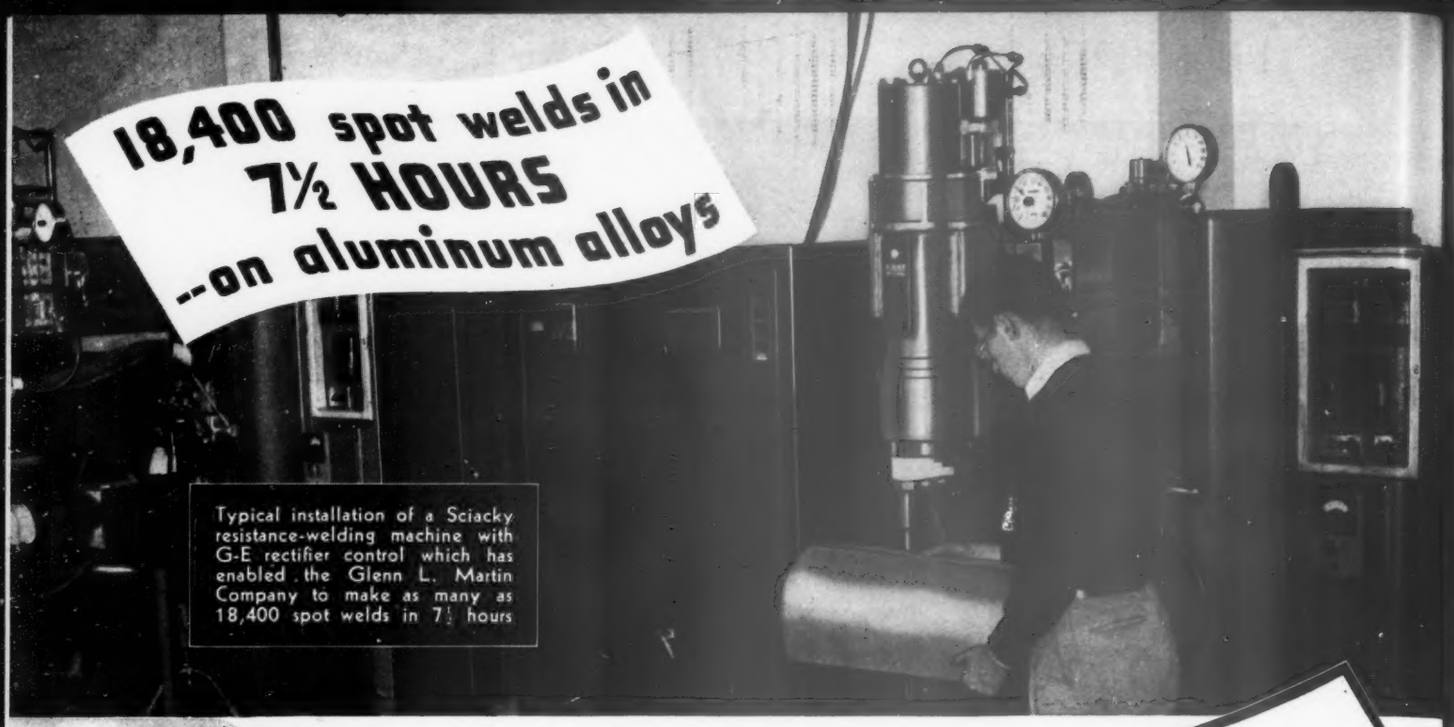
J. A. Ferris of Northwest Airlines describes the equipment used by Northwest in air conditioning its transports during their lay-overs on the ramp between flights (page 160).

Coming

Frank T. Courtney, whose colorful history as a flier and engineer is well known to most aviation people, has prepared a provocative article on remote propeller drives and reaches some conclusions based on his sound experience which will doubtless prove interesting to many fellow engineers.

The accompanying photograph, resurrected from AVIATION's early files, shows him as he looked in 1927, then a captain in Britain's Flying Corps.

The promised article on aluminum conservation is also scheduled for May along with the usual complement of production, design, research and engineering articles of immediate importance.



18,400 spot welds in 7½ HOURS --on aluminum alloys

Typical installation of a Sciacky resistance-welding machine with G-E rectifier control which has enabled the Glenn L. Martin Company to make as many as 18,400 spot welds in 7½ hours

GET CONSISTENT, HIGH PRODUCTION WITH G-E IGNITRON RECTIFIERS

on inductive-type stored-energy welding

PROVED by more than 18 months of actual use in supplying power to inductive-type, stored-energy welding machines, G-E ignitron rectifiers are helping users get fast, dependable operation—particularly in the aircraft industry.

Because of its low kva demand, the inductive type of stored-energy resistance welding permits the use of low-cost plant distribution systems and reduces voltage drop. It also permits installation of welding machines at the most favorable point in the production line—even though this may be at some distance from the distribution transformers.

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General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

Money, Materials and Profits

WHEN CITIZEN JONES relaxes in his comfortable chair at night and reads that 60 billion dollars more have been appropriated by Congress for planes and guns and tanks, he skips the unpleasant report of the latest enemy victory and retires confident that the war is in our bag. He also skips the news item buried on page 24 that Premier Tojo has just told his subjects that "War is not won with money." But this happens to be an instance in which Tokio's bloody dictator is quite right. There is far too much talk about money emanating from Washington these days and it is building up a false sense of security among American people. Neither money nor oratory will help us win this war.

When the final score is chalked up it will be a problem in simple addition. The side having employed the greatest amount of efficiently used man-hours of labor and the largest poundage of materials will be the winner. At the moment we are short on both of these but the most serious shortage is in materials.

The conversion of workers from other industries and even from agricultural pursuits to aircraft makers has been done and is being done with greater ease than was thought possible. The industry has recruited vast armies of workers and placed them along many newly-created production lines. But all of this is of no avail if these workers are required to make bricks without straw.

Aircraft production has been aptly defined by one authority as "the manipulation of shortages." As production rates increase, the whole manufacturing mechanism rapidly becomes more delicate. Failure of an insignificant subcontractor to deliver on schedule, interruption in the predetermined flow of any single part or material, can play havoc with final assembly and upset the efforts of tens of thousands of workers.

After a production line has been set up it is a comparatively simple matter to keep it going, as long as the manufacturer is given what he wants when he wants it. We can reach the high objectives in aircraft production set by the President only if the materials are forthcoming on schedule.

Further evidence of the unimportance of money in the present war effort is found in the annual reports of several aircraft manufacturers, which are discussed elsewhere in this issue. Several of these manufacturers have gone in for a new kind of pioneering which should set an enviable example for other industrialists. They have performed another almost unprecedented feat in voluntarily returning funds to the government. United Aircraft has passed 1941 operating economies back to the Navy Department to the tune of $10,000,000. North American has cut prices on unexpired contracts. Douglas has cut fees on some fixed-fee contracts to 5 percent before taxes, and has reported a net profit on Army-Navy orders of 1.3 percent in 1941.

A number of aviation manufacturers are setting aside reserves for the expenses of their inevitable transition from war to peacetime operations. It is only reasonable to assume that the cost of readjustment after the war will be comparable to the recent change-over from a peace to a war basis. This policy is in full accord with the principles of the American system of individual enterprise and will do much to smooth over the rough spots in the industrial transformation to come. This in turn will simplify the process of readjustment of industrial communities and will therefore relieve the government of some part of that responsibility after the war.

These highly commendable moves should be studied and followed where possible by other manufacturers in aviation and other industries. They indicate sound management in time of emergency and will have the incidental value of making life hard for any congressmen who are trying to make political capital of alleged profiteering in industry.

Leslie E. Neville

AVIATION'S WAR COMMUNIQUE NO. 4

Army command stripped for action, with Air Force attaining full status equivalent to combined ground forces. Billancourt raid start of belated Allied aerial offensive.

PRESIDENT ROOSEVELT and his general staff made one of the important tactical moves in this world war when they stripped the Army down for action. With one devastating order the Commander in Chief reduced it to its three fundamentals: Air Force, Ground Force, and Supply. Most of the tangled military bureaucracy and sacred cows of several generations were swept away with the stroke of a pen.

The autonomous commands of Infantry, Artillery, Armored Force, are abolished. No longer do these unit commands confer and agree what each will do. They get their orders direct from the Commanding General of the Ground Force. They are all coordinated by a single Command, like men on a chess board, with the single purpose of carrying out a mission. The Infantry, Artillery, Cavalry, etc., still exist and it is proper to refer to them as such, but not as branches of the Army.

AIR FORCE IS ON ITS OWN

Air Force, Ground Force, and Service of Supply appear to be equal in rank. They are autonomous, except that they are under a single command: the General Staff, headed by the President. These three divisions, like the various services of the Ground Force are geared together for one purpose: to prosecute successful war.

You can think of the new Army in still another way—as only two parts. One part is the fighting men—the ground troops and the air men. The other part is the supply service, which designs, procures, delivers, and maintains the supplies and weapons for the fighting men.

The logic of this is obvious. Compare it with a job in an operating room. The surgeon is the man at the front, with a staff of experts handing him the tools he wants when he wants them. In our new Army, the warriors will confer with the suppliers at odd times about how their tools work, and what changes should be made, but that is all. There is no overlap of authority.

Look at the effect of the reorganization on the Air Force. Since World War No. 1, the air arm of the Army has been procuring its own planes. A few months ago the Air Corps was reorganized as the Army Air Force, with two divisions: the Combat Command, and the Air Corps. The Air Corps had charge of training, ferrying, personnel, intelligence, material. Thus, the Chief of the Air Force was responsible

AMERICA AT WAR

Left to right: The commanders of the newly reorganized Army: Lt. Gen. Henry H. Arnold, Air Force; Lt. Gen. Lesley J. McNair, Ground Forces; Maj. Gen. Brehon B. Somervell, Service of Supply, and the new Naval Chief of Operations, Admiral Ernest J. King, a flying officer. Accumulated red tape of decades was swept away with the reorganization.

Press Association Photos

These are the British parachute troops who paved the way for the devastating RAF attack on the Renault works near Paris by aiding in the destruction of a German radio detector post in Northern France.

The formidable Bren gun carried by this parachute trooper points up the fire power of the British parachute battalions.

for the fighting, and procurement, and everything else.

UNIFIED COMMAND IN AIR FORCE

The new set-up abolishes the Air Corps. As this was written it seemed almost certain that procurement of airplanes, including research and development, such as that done at Wright Field, plus maintenance, was being transferred to the Service of Supply, where the logic of the scheme seemed to indicate it belonged. This is indeed drastic reorganization—a housecleaning that removes the horsehair sofa from the attic, the high-wheeled bicycle from the cellar, the skeletons from the closets and the stuffed shirts from the parlor.

Likewise the Air Force Combat Command is abolished. This consisted of the 1st, 2nd, 3rd, and 4th Air Forces. You will recall that this command was the GHQ Air Force until the recent formation of the Army Air Force. Now, the Combat Command is out, and the various units report to, and receive their orders directly from, the Chief of the Air Force. A number of other commands: training, ferrying, etc., also report directly to the Chief of the Air Force. Thus, after growing up with the airplane as a fighting machine, General Arnold becomes one of the three commanders of the United States Army. (See page 167 first news page)

Reorganization does not mean that we have the "independent" air force which some sincere congressmen and others have been calling for. It is possible, even probable in the minds of some, that, as the versatility of war planes is developed, the air arm may take precedence over all others. But it becomes increasingly apparent that we are not to have a separate air power in this war. To say never, would be presumptuous. As near as can be determined, there is now no separate air command in the world except RAF. That independence of course is not complete. And even if it were, RAF has several failures chalked up against its brilliant successes.

While the Army Air Force, along with the Army, cast away its excess drag, events abroad indicated it was high time for just such a make-ready. American eyes were still on air action in the Far East, for it looks as if the Japs are our job.

NAVY FOLLOW SUIT

Following close on the heels of the Army changes, a reorganized and streamlined Navy Command was announced. Again, emphasis was placed on the air arm by the appointment of Admiral Ernest J. King as Chief of Operations. During the 1930's Admiral King held just about every command post in connection with naval aviation. He is one of the few high ranking officers qualifying as a naval aviator.

There is a close parallel between the new Navy staff organization and the Army set-up. Admiral King's administrative aids will consist of Rear Admiral F. J. Horne, in charge of planning, organization, and procurement; and Rear Admiral Russell Wilson, supervising details of operations at sea. This set-up eliminates the overlapping and division of commands that heretofore existed in the Navy High Command.

JAPS STILL HOLD TEMPORARY EDGE IN AIR

Nippon's air power figured boldly in the conquest of the East. But now, after four months of war, indications increase that Japanese success in the air is due largely to lack of opposition. They controlled the air in the Philippines, at Singapore, and in Java, because practically nobody else was *in* the air. This happy circumstance for the Sons of Heaven will taper off, though, as more and more B-17's and other Allied craft show up on the other side. Long-range bombers are even more important now than ever, since they will have to hit from Australia and Alaska. They can also attack from Russia, if the Japanese tangle with that country.

EUROPEAN AIR WAR—ALLIES' TURN

Observers had been wondering all winter what ever happened to the projected British air assault on Germany and occupied Europe. Now, it seems that the long winter nights they were counting on were accompanied by unflyable weather. This has been pretty much true with the Russians and Germans also. Their airplane losses have been far less than their production, and it doesn't take a columnist to

(*Turn to page 199*)

Aviation

High over the Andes, a Pan American-Grace Airways DC-2 transport heads south for Santiago, Chile. It is by means of fast air communications for covering the vast distances between the U. S. and the countries of South America that we are expanding our trade with Latin America.

Leonard E. Read

Air transportation is playing the leading role in establishing vital trade relations and a good neighbor policy with Latin American Republics.

THE PRESENT WAR has created a bond between the United States and our South American neighbors that is indisputably strong—at least for the present. The strength of this bond after the war depends principally upon trade, rather than political considerations. This, in turn, depends upon "facility for trade" which means a willingness to trade through mutual understanding of benefits, and availability of communications and transport. And this is where our international airlines will play the major role in cementing hemispheric relations.

The fact that this is a war of economy —a war in which the availability of materials is of paramount strategic importance, is causing us to establish "trade facility" at a speed and to a degree that would have taken decades to accomplish in peacetime with the raw materials of the world at our command. Commercial air transport is making this an easier task, and expanded air transport on an economic, not a war, basis will perpetuate it.

Air transport has already played a large part in the enlarging of our commerce with South America. It has made possible the rapid exchange of written information and samples of products which businesses require in formulating their plans. Of even more importance is the service of air transport in making it possible for business, political and social leaders of both continents to visit each other and establish intimate personal and business relationships.

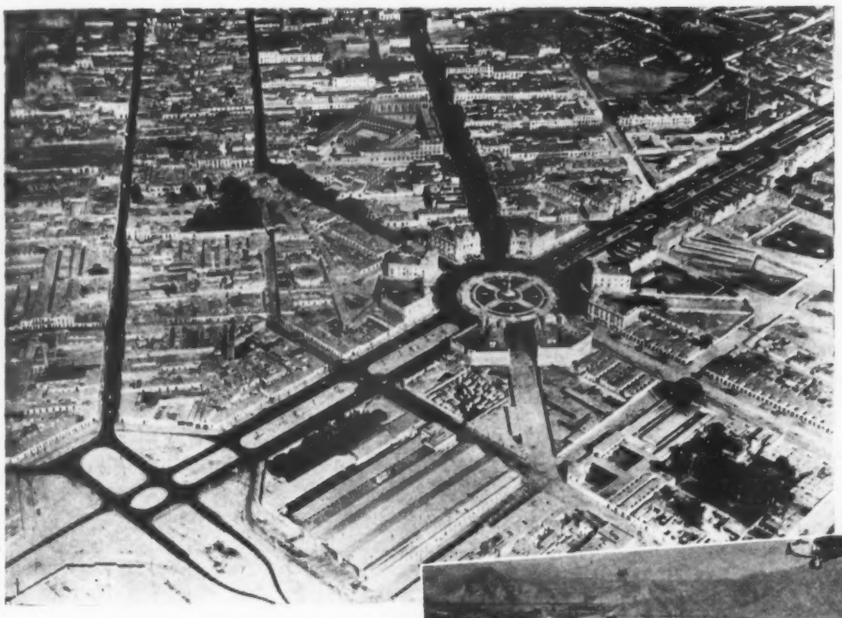
In order to do its part in promoting such close personal and business ties, the Los Angeles Chamber of Commerce has long been active in arranging air tours of South America by business and civic groups. We have also established business offices in Mexico City, Rio de Janeiro and Buenos Aires. Air transport makes it possible to keep in close touch with these offices and to whisk trade tips back to Los Angeles, with

One of the Pan American loading stations in an open roadstead marine airport.

Makes Good Neighbors

By LEONARD E. READ,
General Manager, Los Angeles Chamber of Commerce

Modern apartment houses in Copacabana, a suburb of Rio de Janeiro.



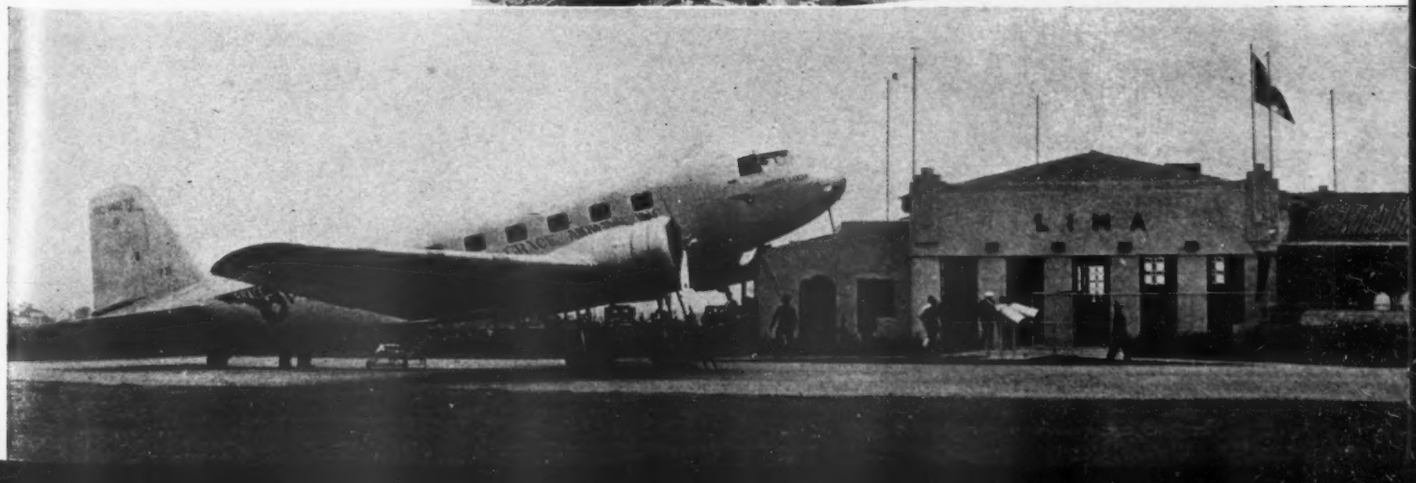
The hub of Lima, Peru, showing the wide avenues and parks.

merchandise samples or premium products sent back by return plane in time to clinch business which could never be handled by any other medium of transportation.

My trip around South America, prior to our entry into the war helped to give me a better grasp of the tremendous problems which have been precipitated by the war. The whole complex fabric of Latin American commerce had already

(*Turn to page 224*)

A Ford tri-motor flying over Santiago, Chile.



The DC-2 "Santa Lucia" of PAA at the Lima Airport in Peru.

Healthy Workers Produce More

By HARVEY M. HALL

In the battle for production, improvement in the health of workers not only reduces time lost from the fight, but builds morale and increased efficiency. Nutritious food, sanitary precautions, recreation and health education speed the work.

NO ONE in wartime England doubts that absenteeism of industrial workers is a grave problem. Blame cannot be placed on industrial accidents, which because of safety measures instituted since the last war have been reduced to a comparatively small number. According to British authorities, today's absenteeism is due, chiefly, to illness and lack of morale.

A program aimed at protecting and improving the general health of employees here as in England, it is believed, not only will reduce absences due to illnesses but also will build morale.

Fatigue is an outstanding cause of low production. It results in poor health and poor morale and its control improves both. As the all-out war program swings into high gear, measures to curb fatigue become at once important. The experience of England may serve as a guide. Last year the British Ministry of Information reported that a plant manager had summed up the whole overtime situation when he said that "working a seven-day week means paying for eight days (double pay for Sundays) and getting only six days' output." Accordingly, last summer, the Ministry of Supply recommended a three-shift system and the government later authorized a 60-hour work week with one day's rest, preferably on Sundays. Already the Ford Motor Company has had to revise working schedules. Long working hours, officials announced, "were found to have ill effects" on men producing aircraft engines. Their week accordingly has been trimmed to 58 hours a week with Sunday work eliminated.

In addition to efficiently planned work schedules, a measure that can strengthen tremendously both health and morale is the provision of proper food, served conveniently, sanitarily and attractively, at appropriate intervals. Everyone who has ever leaned back from the table after a satisfying meal, and sighed "Now I feel *good*" knows how food may lift morale.

The first large-scale attempt to assess

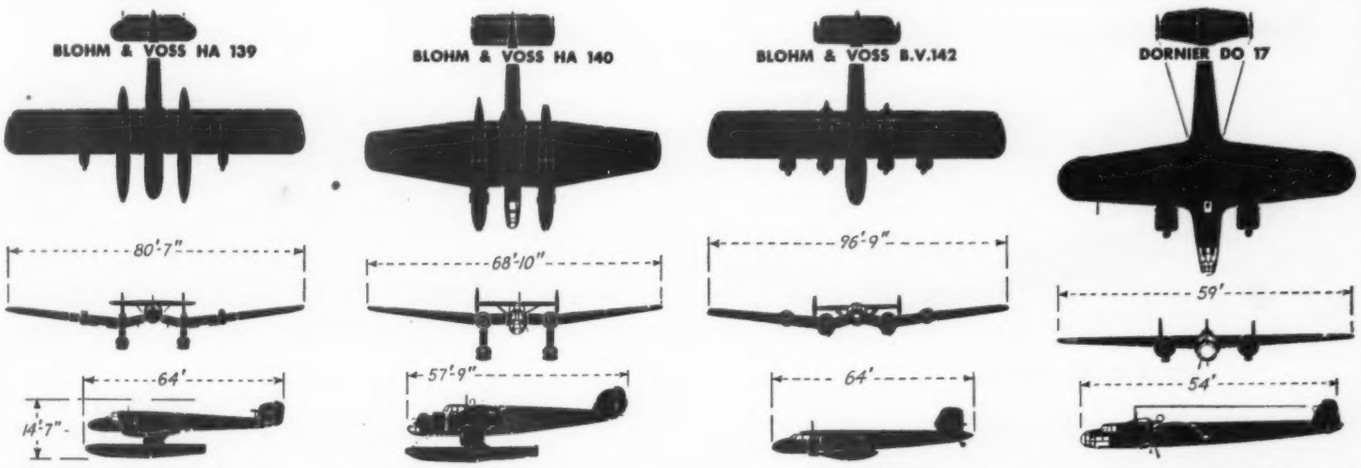
(*Turn to page 196*)

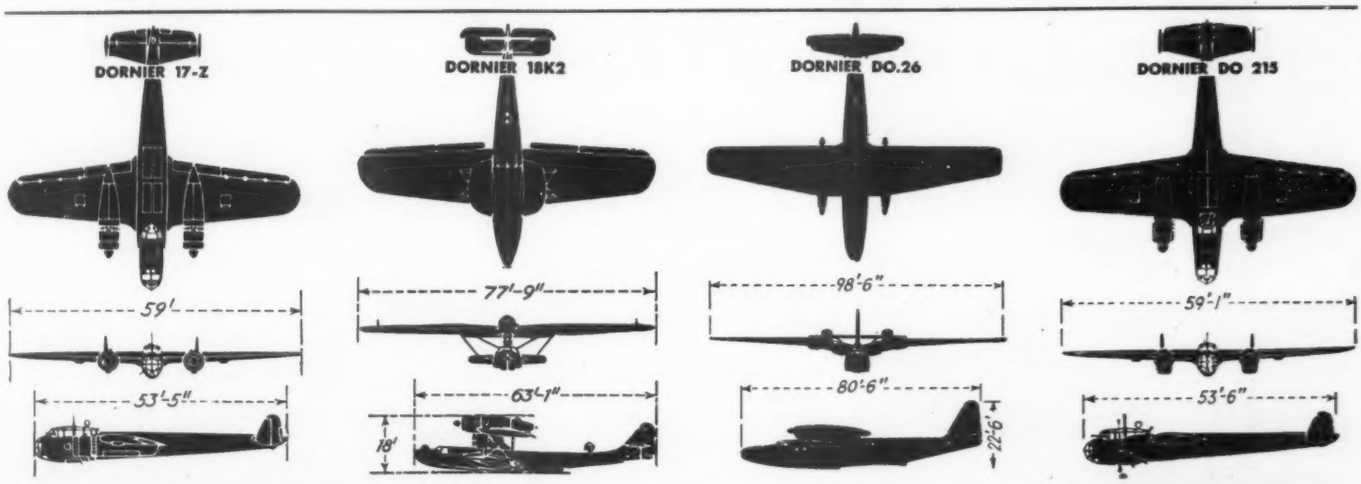
Left: This, too, aids production. Kay Dorwin, West Coast aircraft worker, bowls with one of the numerous Lockheed teams. Below: More than 5,000 Lockheed and Vega employees working the "graveyard" shift packed the service hangar at Burbank, Calif., when Kay Kyser broadcast his regular program from the aircraft plant.

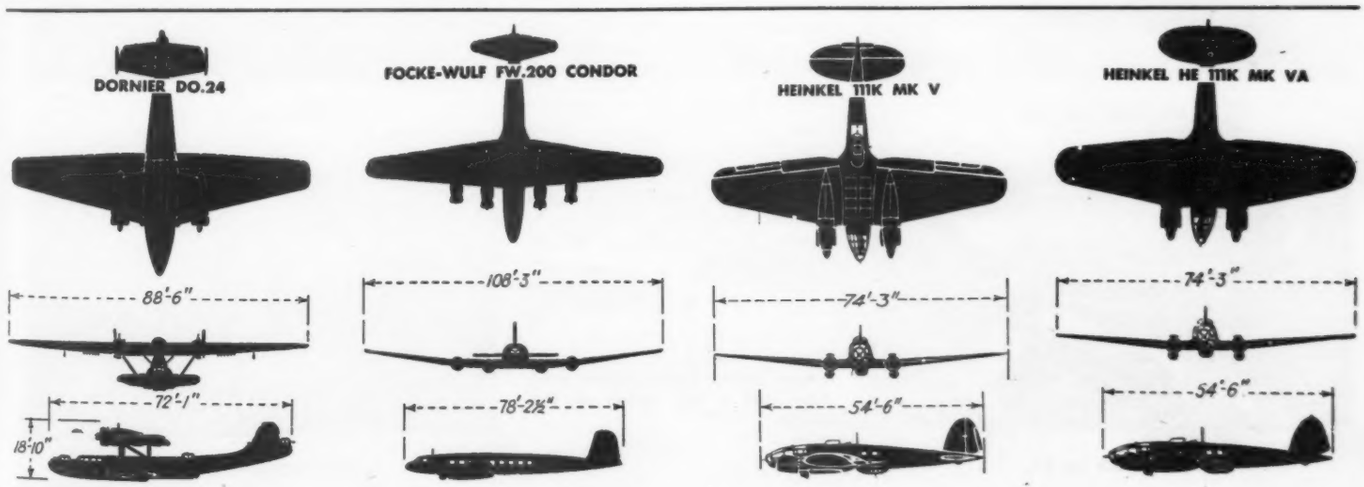
German Aircraft

No outstanding new military models have been produced in Germany since the outbreak of war in September, 1939. Newest types used by the Nazis are derivations of successful aircraft of pre-war development.

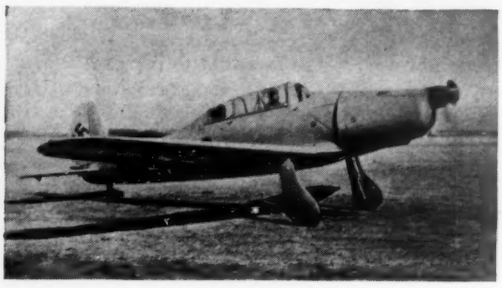
There has been much conjecture over the possibilities of air raids by German long range bombers, particularly the Heinkel 177. On paper this bomber has a theoretical maximum range of 7,040 mi. with a 1000 lb. bomb load. Consideration should be given, however, to the fact that to increase the normal range of 1,863 mi. to this extent would necessitate the installation of huge fuel tanks in the fuselage. Bomb loadings would then have to be carried externally, thereby greatly increasing drag and reducing speed. Another unfavorable factor facing European-based bombers is that strong headwinds always prevail over the North Atlantic which can spell failure for the mission.





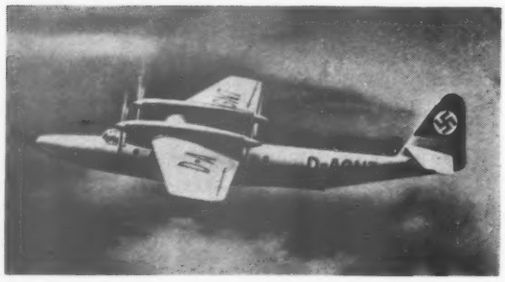


GERMAN AIRCRAFT



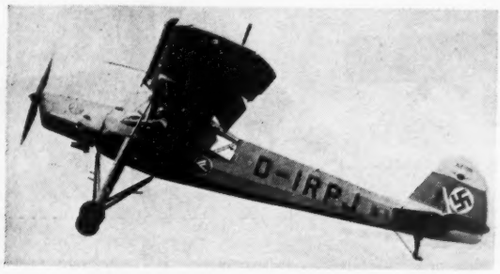
ARADO 96 B.

◀ Two-seater advanced trainer of all metal construction. Has a cantilever low wing and monocoque fuselage.



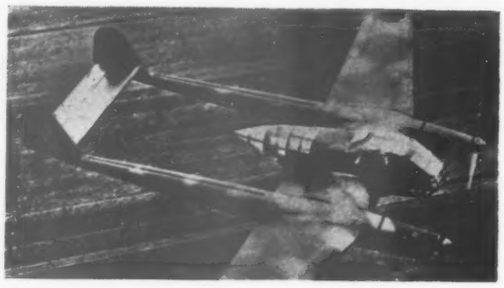
▶ Built as a trans-ocean mail carrier. it has a 5000 mile range rendering it adaptable for naval reconnaissance. It has four Diesel engines.

DORNIER Do. 26.



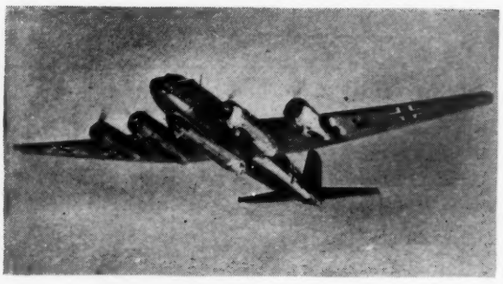
FIESELER Fi. 156 STORCH.

◀ A fully slotted and flapped high wing monoplane for army co-operation with exceptional speed range.



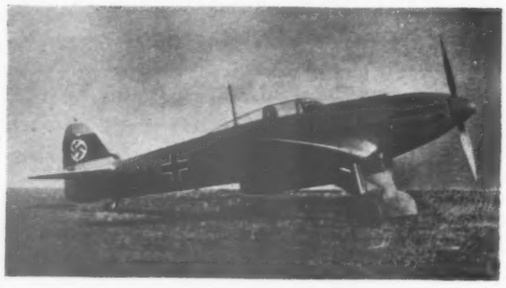
▶ A twin engine, all metal, three seater general purpose monoplane distinguished by two tail booms. Top speed is 221 m.p.h.

FOCKE-WULF Fw. 189.



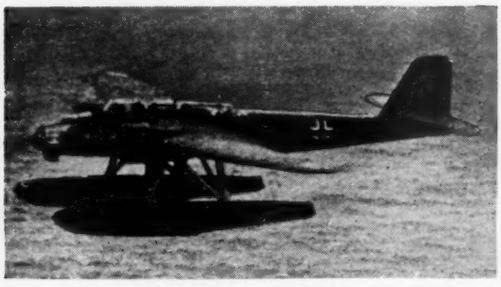
FOCKE-WULF KURIER.

◀ A militarized version of the Fw-200 Kondor transport. Its long range has made it effective in attacks on ocean convoys.



▶ A high performance single seater fighter, an improved version of which is the He. 113, said to have a top speed of 400 m.p.h.

HEINKEL He. 112.

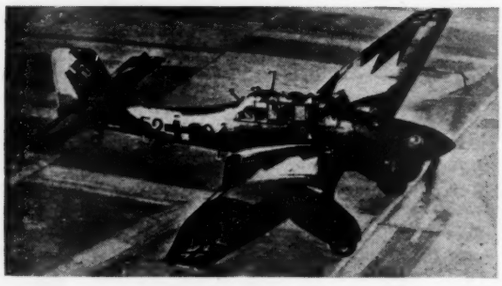


HEINKEL He. 115.

◀ Long range, all metal torpedo carrier of mid wing type. Has a top speed of 217 m.p.h.

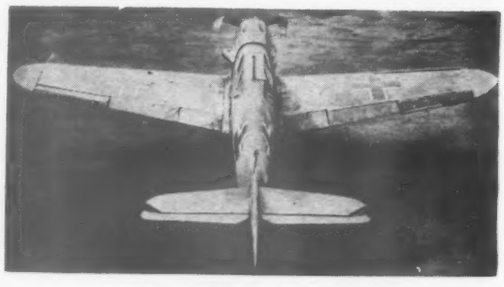
▶ An army co-operation two seater of the high wing type. Has an all metal monocoque fuselage.

HENSHEL Hs. 126.



JUNKERS Ju. 87.

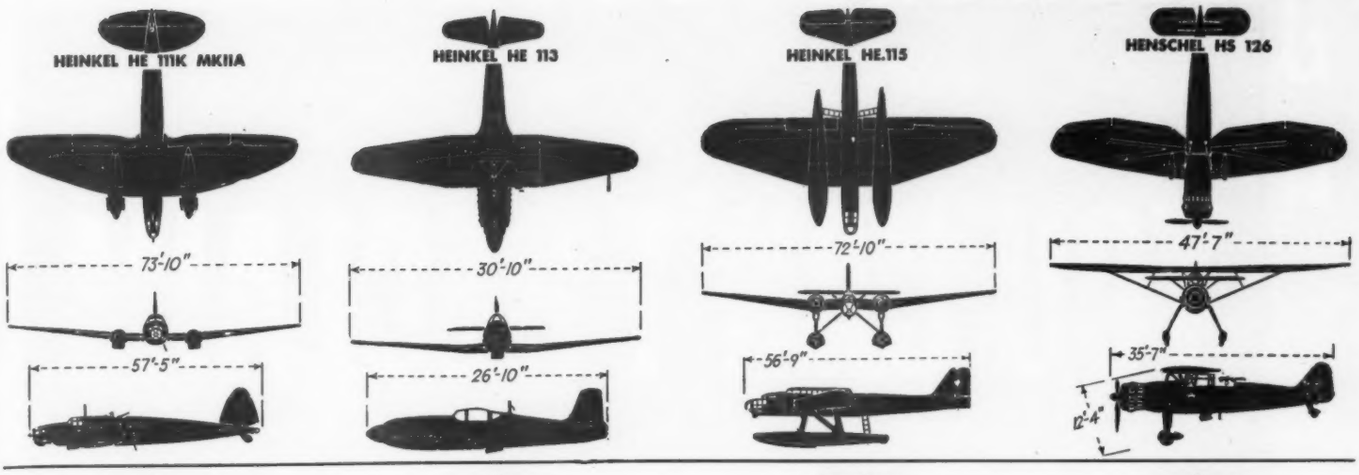
◀ Robust and serviceable dive bomber. Top speed of 242 m.p.h. makes it vulnerable to ground or air attack.

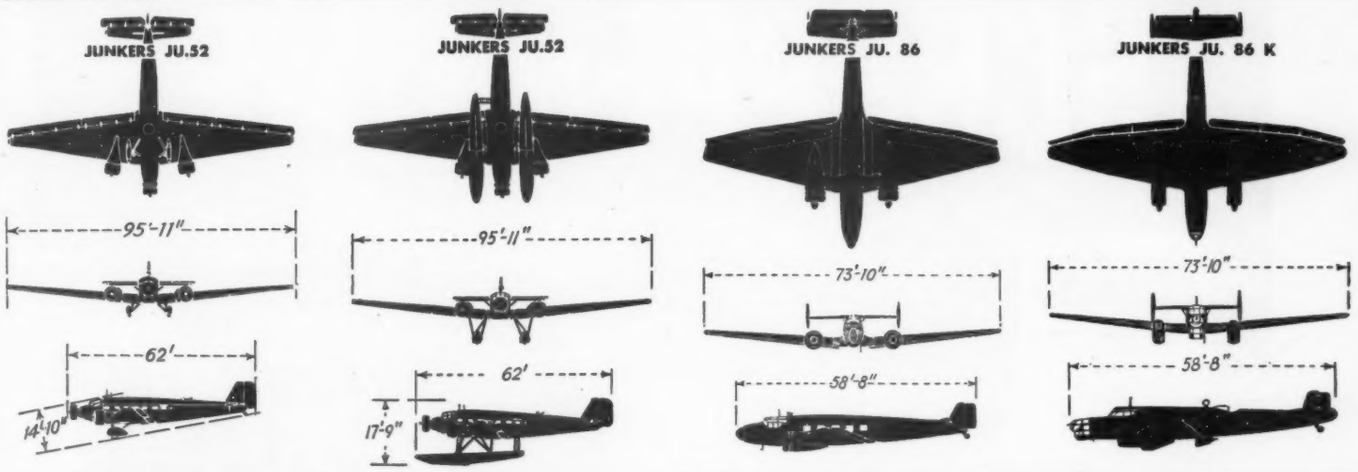


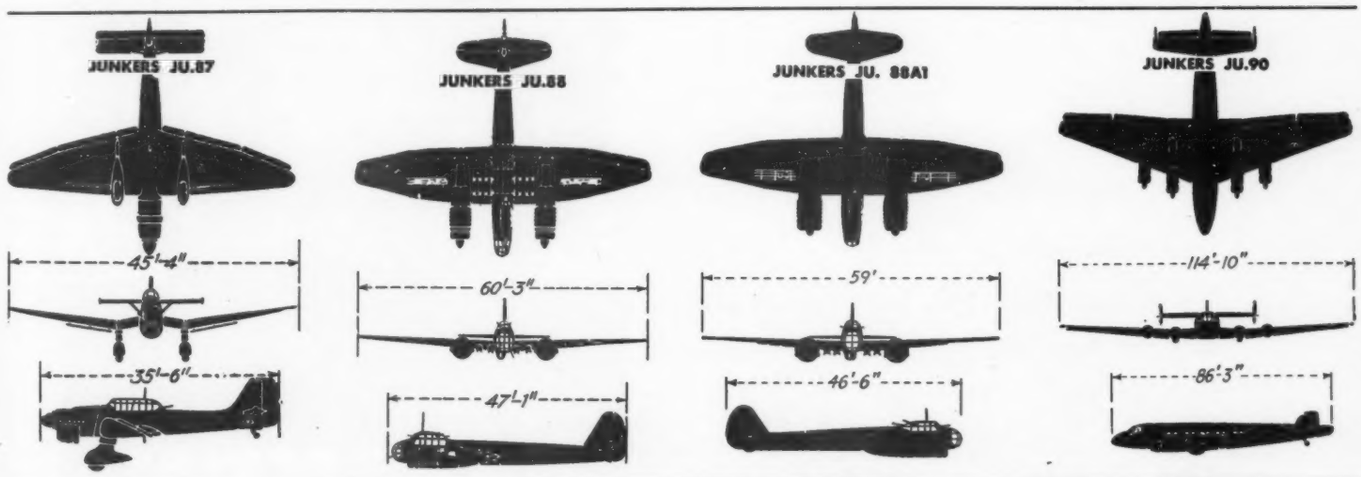
▶ Latest version of the single-seater fighter has rounded wing tips and a top speed of 380 m.p.h.

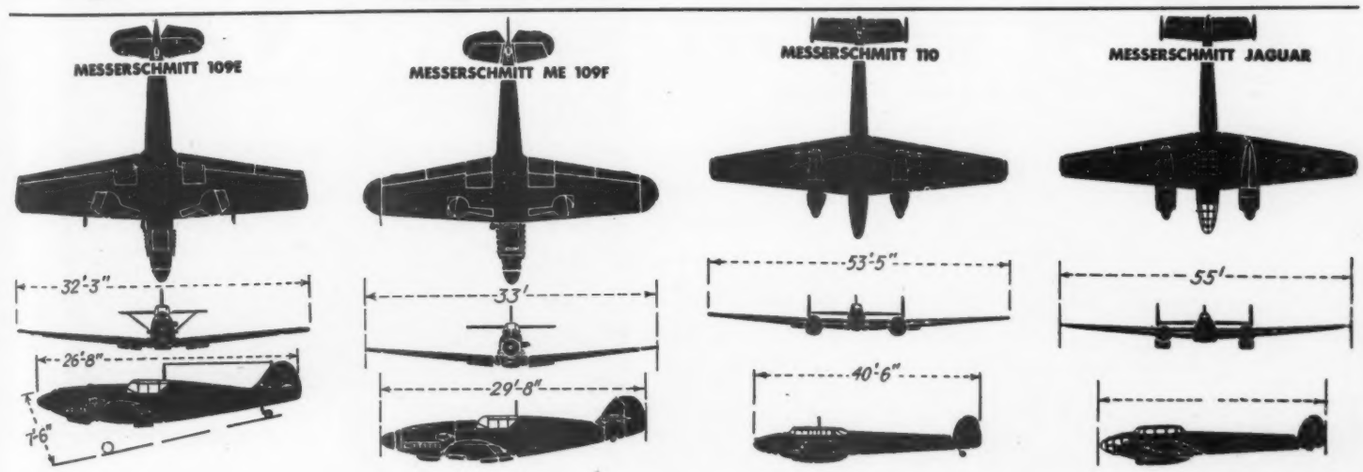
MESSERSCHMITT Me. 109-F.

GERMAN AIRCRAFT









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MANUFACTURING

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PRODUCTION
DESIGN
RESEARCH
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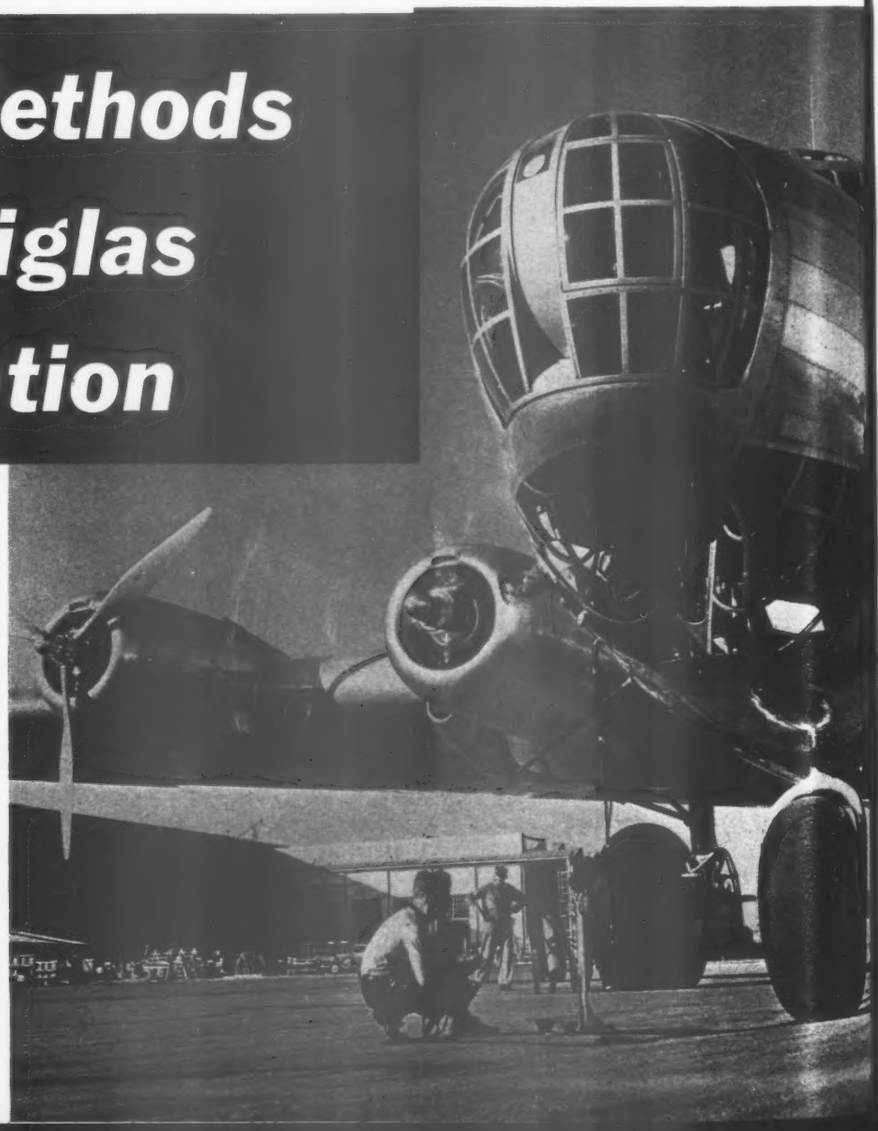
Correct Methods Of Plexiglas Installation

Plexiglas has proved its permanence during years of service under severe conditions, but proper installation is essential to provide such satisfaction. Here are the basic principles to guide designers and engineers who are responsible for providing methods of installation.



MANY of the first Plexiglas installations in military aircraft are still seeing active service. Time and sun and weather have made only minor inroads on the transparency and dimensions of the material, changes of only academic interest.

Plexiglas has proved its permanence even under severe weather conditions—*provided, however, that it has been properly installed.*

When proper consideration has not been given to the properties and limitations of the material, Plexiglas has occasionally cracked or crazed. Usually it has not failed so fast as other types of transparent plastics fail under more favorable conditions; but in such cases it has not given the long service aircraft designers have come to expect of it.

Since correct installation is so essential for satisfactory service, this article is aimed in that direction. It not only contains specific suggestions for mounting Plexiglas but outlines the considerations behind these designs. It does not pretend to exhaust the possibilities of the subject; but it does lay down basic principles for the guidance of the designers, engineers and production personnel for whom it is written.

PRINCIPLES OF SUCCESSFUL INSTALLATIONS

"Plexiglas" is the registered trademark for the acrylic resin thermoplastic sheets and rods manufactured by the Röhm & Haas Co. It has fully met and passed the following specifications:

U. S. Army—"Plastic, Sheet; Acrylate Base," 94-12014B

Navy Aeronautical—"Plastic, Transparent, Flame Resistant," P-41c.

Just as woods split and metals crack around an area of high localized stresses, so Plexiglas and other transparent plastics are apt to develop a pattern of tiny fissures under similar conditions. This effect, called crazing, can best be seen by looking along the surface of the sheet.

Crazing occurs when differences in stresses between the surface and the interior of the plastic are sufficient to crack its "skin." An improper installation may create just such differences by bringing large forces to bear on limited areas of the Plexiglas.

There are no unequalized internal stresses in flat Plexiglas sheets because every piece is subjected to a heat treatment (similar to annealing in glass) in the course of its manufacture. This process, developed by the Röhm & Haas laboratories, eliminates any unequalized stresses set up during the casting of the sheet. In effect, it preshrinks the material so that no further significant dimensional changes take place in spite of weathering and other service conditions.

Small local stresses may be set up by sawing or machining Plexiglas, but these are of no great moment unless a considerable area of material is involved. To a certain extent, stresses are also set up during the forming of a Plexiglas sheet into a curved section. If the material is even reasonably hot when formed, however, these stresses are well distributed throughout the section. Crazing may occur in a formed piece when a solvent for Plexiglas attacks the surface and releases some of these stresses unequally. This may happen, for example, when a cleaner containing such a solvent is used on a formed cockpit enclosure.

Neither weathering alone, however, nor other service conditions short of solvent action cause crazing even in a piece of Plexiglas which has been con-

By Dr. D. S. FREDERICK
Röhm & Haas Co.

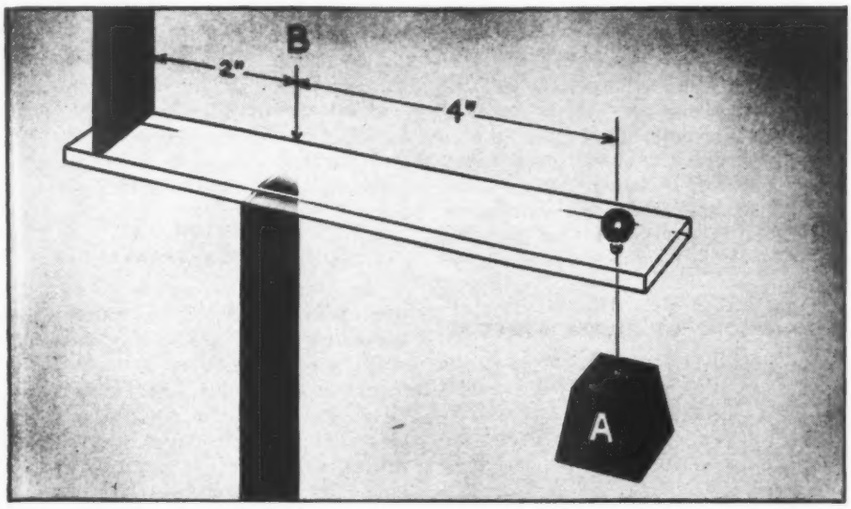


Figure 1. Accelerated crazing tests for Plexiglas.

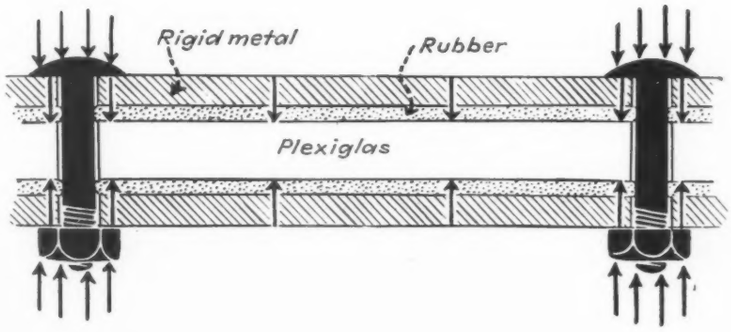


Figure 2. If metal channel members were perfectly rigid, stresses applied on the bolts would be distributed equally over the intervening areas of Plexiglas. Absolute rigidity may be impractical in light-weight installations; but the stiffer the members the better the stress distribution.

TABLE I—Accelerated Crazing Testing for Plexiglas

Outer Fiber Stress	Nature of Exposure	Length of Exposure							
		4 hours	24 hours	4 days	6 days	16 days	32 days	56 days	120 days
508 lb./sq. in.	indoor	OK	OK 0°	OK 0°	OK 0°	OK	OK	OK	OK
477 lb./sq. in.	outdoor	OK	OK 0°	OK 0°	OK 0°	OK	OK	OK	OK
945 lb./sq. in.	indoor	OK	OK 0°	OK 0°	OK 10°	OK	OK	OK	OK
948 lb./sq. in.	outdoor	OK	OK 0°	OK 0°	OK 5°	OK	OK	very slight crazing	same
1880 lb./sq. in.	indoor	OK	OK 0°	OK 0°	OK 15°	OK	very slight crazing	same	same
2090 lb./sq. in.	outdoor	OK	OK 0°	OK 0°	OK 15°	OK	OK	some crazing	same
4030 lb./sq. in.	indoor	slight crazing	More 30° crazing	very 35° crazed	same	same	same	same	same
3520 lb./sq. in.	outdoor	OK	some 30° crazing	some 39° crazing	same	same	same	same	same
			In these three columns the amount of deflection from the horizontal is given in degrees. (estimated)						

siderably stretched during forming.

Crazing reduces the transparency of a plastic, but, more important, it is a symptom of a nearby high stress differential and a warning that the material has been seriously weakened. A crazed plastic section should be replaced as soon as possible. It is not enough to remove the craze marks by light local heating or by other superficial methods. The condition which caused the crazing must be remedied if continued service is expected.

CAUSES OF CRAZING

To determine the stress differential at which crazing develops, strips of Plexiglas 7x1x.250 in. were placed in racks arranged as in Fig. 1. Various weights were hung at A to produce outer fiber stresses at B of approximately 500, 1,000, 2,000 and 4,000 lb. per sq. in. These stresses were calculated from the following formula, based on a 2:4 beam ratio: $F = \frac{24.L}{WT^2}$ where L is the load at A in pounds, W is the width and T is the thickness of the strip in inches.

Two racks were used; one was placed in a dark closet, the other was exposed to the weather from August to January.

The results, summarized in Table I, lead us to recommend a *maximum stress of 900 to 1,000 lb. per sq. in.* if extended outdoor service is expected of the Plexiglas. Since, within this limit, Plexiglas retains its original transparency and strength indefinitely, every effort should be made to keep stresses below the given maximum no matter how favorable the anticipated service conditions.

AVOIDING EXCESS STRESSES

The obvious way to avoid excess pressure on any part of the Plexiglas is to distribute the total stress over as large an area as practical.

Thus the ideal method of mounting Plexiglas is in an extruded or riveted channel. Here stresses are distributed, to a certain extent at least, all along the edges gripped by the channel. Naturally, the deeper the channel the larger the *area* carrying the total stress. Variations in the thickness of the Plexiglas (nominally 10 percent) and in the width of the channel, preclude absolutely equal distribution of stress; ut when reasonable care is taken to keep the clamping action uniform all along the frame, excess pressure at any one point can be avoided.

Unfortunately, it is not always possible to use a simple channel or clamp mounting. At high speeds, air flow may pull a large, thin section out of its channel unless it is bolted or riveted or unless some other retaining device is used. A high crowned section may also require positive attachment.

Where bolting cannot be avoided, the possibility of high stress concentrations can be reduced by using a large number of bolts, each carrying an approximately equal share of the load. Also, the more rigid the channel members, the more effectively they will prevent the development of excess compressive stresses on the Plexiglas around the bolt or rivet holes. (See Fig. 2.) Fig. 3 shows what may happen if these members are too flexible to distribute the load over the Plexiglas between bolts.

CARE IN INSTALLATION

Even these precautions may be nullified if an over-enthusiastic mechanic decides to install a Plexiglas section "good and tight." All too easily a man can screw a nut and bolt tight enough to develop more than 1,000 lb. per. sq. in. pressure on the plastic. Or he can force a section far out of shape in fitting it into a frame, thereby setting up high and unequal stresses.

Workmen should therefore be instructed to avoid strong arm methods in installing Plexiglas sections just as they should be warned against scarring its surface. It may also be possible to equip them with tension wrenches so that forces over a given limit cannot be applied to a nut or screw. If this is not practical, instruct assembly men to tighten each screw or nut—*and then to back it off one full turn.*

SAFER TO USE SPACERS

It is the better part of wisdom, however, to design an installation which cannot put the Plexiglas under any great pressure.

One good solution is to provide tube spacers to fit around the bolt and thereby protect the Plexiglas from direct pressure. Similarly, it is also possible to use long-shank bolts or shoulder rivets or cap nuts to make it impossible to bring the channel members closer together than the thickness of the sheet plus a reasonable clearance for thickness variations and for rubber packing. Thus, without complicating production procedure, it is possible to provide protection and assure longer service for the Plexiglas.

FUNCTIONS OF RUBBER GASKETS

It should be pointed out that the rubber gaskets recommended in most Plexiglas installations do not effectively prevent development of high stress concentrations. Their principle functions are three:

1. To make the installation waterproof.
2. To reduce vibration.
3. To help compensate for thickness variations in the Plexiglas and width variations in the channel.

They help to distribute stresses only to a minor extent and only when the stresses are relatively small. When stresses are large, these rubber strips are apt only to transfer them from one small area to another small area and to reverse their direction so that they act almost in shear against the original pressure, as shown in Fig. 4. This is less apt to be true of thick soft rubber gaskets; but it is entirely possible for rubber to produce stress conditions which will cause the Plexiglas to fail in an installation which might otherwise be satisfactory.

The term "rubber packing" used here and in the sketches refers to synthetic or natural rubber strips or combinations of either with cork, fabric or felt. Strips coated with an adhesive on one side will facilitate installation especially in the channel and clamp mountings. The rubber should be soft (30 to 50 durometer) and should be approximately .060 in. thick to accommodate variations in the Plexiglas and in the channel.

The effectiveness of rubber in this respect is twofold: it can be deformed locally to almost one-half its thickness or, by painting inside the channel with oil, it can be swollen to double its thickness. Thus a rubber gasket normally .060 in. thick might range in thickness from .030 in. to .120 in. in a single channel installation.

In addition, there are several so-called rubber or mastic compounds, of putty-like consistency when purchased, which harden with age. These compounds may help to make an installation waterproof and possibly to reduce vibration. Of course they do not help to distribute stresses.

In any case, these compounds should be selected with care since they may contain solvents for Plexiglas. It is a simple matter to cover a small formed piece of Plexiglas with the material for several days and then to examine it for swelling or crazing. This rough preliminary test should be followed more complete and controlled tests.

EXPANSION AND CONTRACTION CLEARANCES

The coefficient of expansion of Plexiglas is 5×10^{-5} per degree F., which is higher than the coefficients of materials with which Plexiglas is apt to be mounted. This difference means that allowance must be made for the Plexiglas to expand or contract in relation to the expansion of the metal frame, or binding and dangerously high stresses will result.

When a simple, boltless channel mounting is used, Plexiglas can expand and contract simply by slipping along the channel—unless, of course, the channel clamps the material too tightly at any point.

With medium sized pieces, it is possible to bolt at only one end and to allow the expansion to be taken up by slippage at the other end. With larger pieces, it may be preferable to bolt at the center of the long edge, providing for expansion and contraction at each end. If the Plexiglas panel is free to expand at both ends, only *half* the total expansion clearance need be provided at *each* end.

Wherever the size of the section or design of the frame makes it necessary to drill holes through the plastic and bolt or rivet it to supporting members, the holes in the plastic must be oversize so as to allow some movement of the plastic relative to the metal frame. If the holes in the frame and in the plastic are drilled at the same time, the plastic should be removed and the holes redrilled to the larger size. These oversize holes must be made concentric to the ones in the frame so that the bolt or rivet does not bind at one edge, causing crazing or failure at these holes.

In sections of hemispherical shape similar to an airplane nose or gun turret section, temperature changes will cause the spherical surface to expand or contract as unsupported area. These changes of contour have given no trouble with Plexiglas sections up to 40 in. in diameter; but it is important that provision for radial changes be made at the circumference, where the section is attached to the supporting frame. Elongating the holes in the supporting attachment is one possibility. Another successful design calls for cementing a Plexiglas annular ring all around the edge and drilling the elongated holes in this ring. The ring also gives rigidity

to the section which facilitates handling and reduces breakage in installation.

CALCULATING CLEARANCES

For example, a high altitude plane might encounter temperatures as low as -60 deg. F., or as high as 140 deg. F., in service. For a panel installed at 70 deg. F., expansion and contraction clearances would therefore be calculated as follows:

Coefficient of expansion (°F):	0.00005
Maximum temperature increase:	x 70
If expansion is possible at both ends of panel:	+ 2
Since aluminum and other metals have approximately half the coefficient of expansion of Plexiglas:	+ 2
Expansion factor:	0.0008 or 0.001

Similarly, for a 130 deg. F. drop in temperature, a contraction factor of 0.00162 (or 0.002) is obtained. These factors, multiplied by the length of the Plexiglas panel, are specified for clearances in the sketches.

In calculating clearances for the radial expansion and contraction encountered at the edges of hemispherical sections, the diameter is multiplied by the above factors to determine the length of the elongated bolt holes.

RECOMMENDED THICKNESSES AND FACTORS

The determination of the proper Plexiglas thickness for any given installation is dependent on many factors, most of them beyond the scope of this article. To mention a few of the more important ones, the area, for example, is important because the more completely the panel is supported, the thinner the Plexiglas that can be used. The following table may serve as a rough general guide for flat panels:

Thickness	Maximum recommended area
.060 in.	6 x 6 in.
.080 in.	12 x 12 in.
.100 in.	18 x 18 in.
.150 in.	24 x 24 in.

Shape is also a consideration, for a long narrow panel need not be as thick as a square panel of the same area.

Curvature should also be considered, since even a slight bend in Plexiglas will add to its rigidity and strength. It should be remembered, however, that in forming a three-dimensional section, the Plexiglas is stretched and is thereby thinned out to a degree dependent upon the extent of the stretch.

Ribs cemented to the panel will also add rigidity and strength, according to the thickness and position of the ribs.

The method of installation will in itself affect the choice of thickness in many ways. If the edges are to be routed, moderately thick Plexiglas will automatically be required, although reinforcing ribs cemented along these edges will make possible the use of thinner material in the rest of the panel.

If the Plexiglas is installed in a deep channel, the panel may be flexed through quite a wide range without pulling out; a more shallow channel will require more rigid (thicker) Plexiglas. If the panel is bolted, it is less likely to pull out and thinner material may therefore be used.

The pressure differential between one surface of the panel and the other is obviously important. In aircraft installations, this factor is dependent on aerodynamic considerations which are, in turn, dependent on the location of the panel on the plane and on the speed of the plane. Since the theoretical maximum differential in these cases is approximately 15 lb. per sq. in., we have determined the deflection caused by this pressure at the center of 12-in. diameter disks of Plexiglas of various thicknesses. The data given below is intended only as a general guide. In its interpretation, the reader should consider all of the other factors mentioned above.

Thickness of 12 in. diameter disks of Plexiglas	Deflection at 15 lb./sq. in. water pressure
.125 in.	.65 in.
.187 in.	.56 in.
.250 in.	.41 in.
.375 in.	.23 in.
.500 in.	.19 in.

CHANNEL AND CLAMP MOUNTINGS

FIGURES 5 TO 10

Wherever possible, avoid bolting or riveting through holes drilled in the Plexiglas. Channel and clamp installations are usually preferable from the point of view of mass production methods and are definitely superior in distributing stress.

In this type of mounting the principle precautions are:

1. The channel should be oversized to permit free linear expansion and contraction of the Plexiglas relative to the frame.

2. When installing Plexiglas, care should be taken to keep the clamping action uniform over all of the area clamped.

3. The channels should be deep enough to hold the Plexiglas securely despite flexing and thermal contraction. A safe rule is that Plexiglas panels up to 12x12 in. area should extend into the channel .625 in. plus the contraction clearance (.002 in. times the length of Plexiglas); larger panels, 1.0 in. plus contraction clearance.

In calculating these allowances, remember that linear sawing tolerances for Plexiglas are ±.030 in. for panels up to 12 in. long and ±.060 in for longer pieces.

SIMPLE CHANNEL INSTALLATION

Figure 5

The principles behind the type of installation shown in this sketch apply to both H-channels and U-channels. No bolts, screws, or rivets pass through the

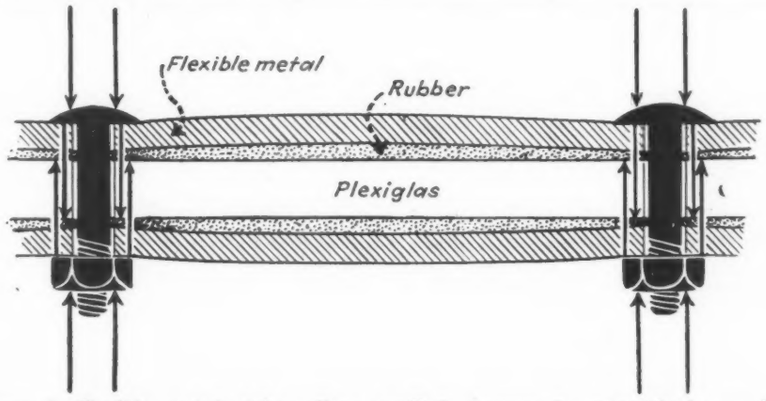
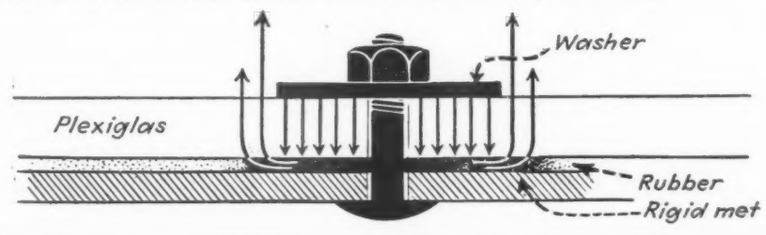


Figure 3. Flexible metal strips allow applied stresses to concentrate on the Plexiglas around bolt holes. In practice, all channel members are apt to be somewhat flexible—hence the need for spacers and other devices to protect the Plexiglas from direct pressures which may cause crazing and failure.

Figure 4. Compressive stresses applied at washer are transferred by rubber gasket into shear stresses acting on the Plexiglas at edge of washer.



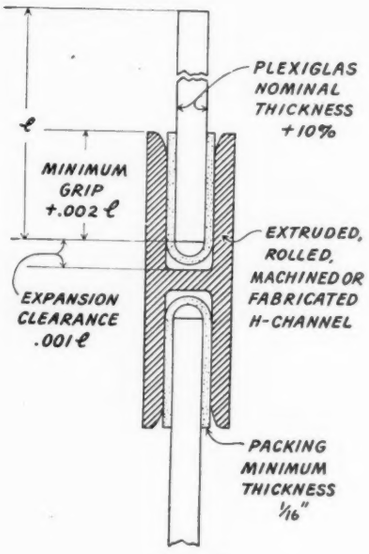


Figure 5.

Plexiglas. Where joining or reinforcing the channel involves the use of such fastenings, the edge of the Plexiglas is cut out to avoid them.

A bell-mounted channel, as indicated in the sketch, makes for faster assembly than sharp-edged channel members and reduces the danger of scratching the Plexiglas during installation.

In assembly, use rubber strips coated with adhesive on one side. This packing can quickly be wrapped around the edge of the Plexiglas and will stay in place while the panel is being inserted.

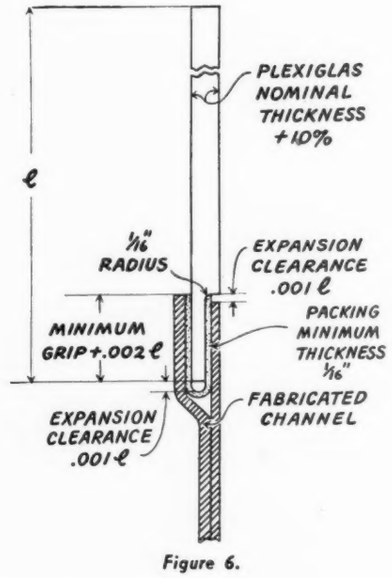


Figure 6.

FLUSH CHANNEL INSTALLATION

Figure 6

One of the advantages of Plexiglas is that it can be routed along its edges to make possible the type of mounting shown here. The plastic is held securely, yet the outside surface is flush with the mounting frame.

The corner of the shoulder of the rout should have a slight radius to reduce the danger of a crack's starting at that point. The fabricator can produce this effect by grinding down the sharp edge of the rout cutter.

The cutter can be adjusted to maintain close tolerances (±.010") in either the depth or the toe of the route. Because of thickness variations in the sheet, it is not possible, in a single routing operation, to maintain these tolerances in both toe and depth. When both these dimensions are critical, a second routing operation is necessary—with a corresponding increase in fabricating costs.

FLUSH INSTALLATION WITH RIB

Figure 7

The Plexiglas may be gripped more securely—without sacrificing the advantages of a flush mounting—if a reinforcing rib is cemented to the edge and clamped as shown in this sketch.

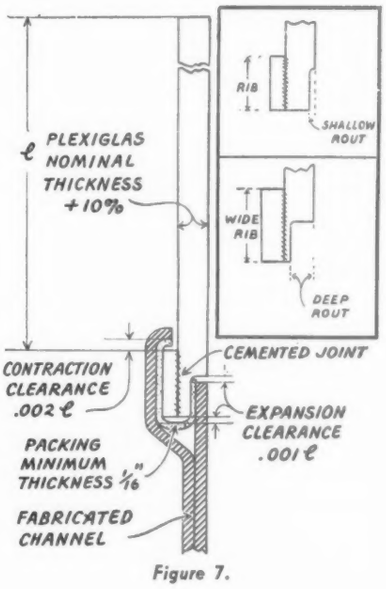


Figure 7.

The relation between the depth and shoulder of the rout, and the width and thickness of the rib is complex and cannot be set down in hard and fast rules. If possible,

(a) The minimum thickness at any point in the Plexiglas assembly should not be less than the thickness of the Plexiglas panel.

(b) The rib should be roughly twice as wide as the thickness of the Plexiglas, since the tensile strength of Plexiglas is approximately double its shear strength.

(c) The rib should not be the same width as the rout, i.e., the edge of the rib should not be opposite the end of the rout, if concentration of stresses at this point in the assembly is to be avoided.

ANNULAR RING INSTALLATION

Figure 8

For hemispherical sections such as noses and gun turrets, the type of installation shown here has proved successful.

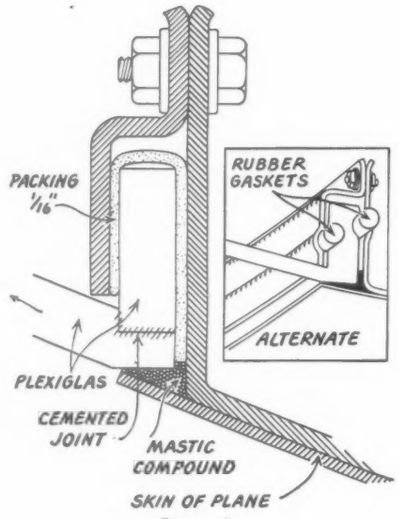


Figure 8.

A Plexiglas annular ring is cemented around the whole circumference of the nose or shell. This circumference must first be routed as shown in the sketch so that the two surfaces to be cemented together will be flat and so that the rib will not slip while the cement is setting.

Many of the stresses set up in service will be along the Plexiglas shell, as indicated by the arrow in the sketch. The annular ring acts as a lever, multiplying the bending moments set up in the metal clamping ring. To minimize this lever action, the edge of the ring should follow, as closely as possible, the joint between the annular ring and the shell.

In pressurized cabin installations, the lever action may be used to advantage by inserting round rubber tubing at the indicated points. As pressure increases, these gaskets become tighter and hence seal the joint more effectively.

The outer edge of the Plexiglas shell is routed so that the section may be

installed after the metal work is completed and so that it may expand radially.

PATENTED CHANNEL INSTALLATIONS

Figure 9

The patented frame shown here in cross section is typical of a number of simple installations which have proved practical on many planes.

It consists of an aluminum extrusion which is bolted or riveted to the skin of the plane. A rubberized fabric tape is put in position around the inside of the frame and the Plexiglas placed against

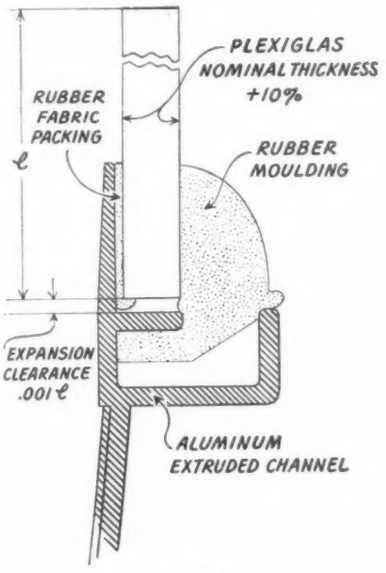


Figure 9.

that tape. Then a heavy rubber extrusion is snapped into position to hold the Plexiglas in place. This extrusion is so designed that any one of a number of thicknesses of Plexiglas may be used without changing the dimensions of the aluminum or rubber parts.

Notice that the Plexiglas is held by the uniform clamping action of the rubber and that the possibility of building up concentrated stresses is therefore quite remote. This type of mounting is satisfactory for pressure cabin installations as well as for low altitude planes.

* Reproduced through the courtesy of the Hunter-Sash Company, Flushing, N. Y. A number of variations of this principle are available from this company and from other companies serving the aircraft industry.

WEDGE SECTION INSTALLATIONS

Figure 10

When two Plexiglas panels must be installed edge to edge and supported along these edges, the type of installation shown here may be used.

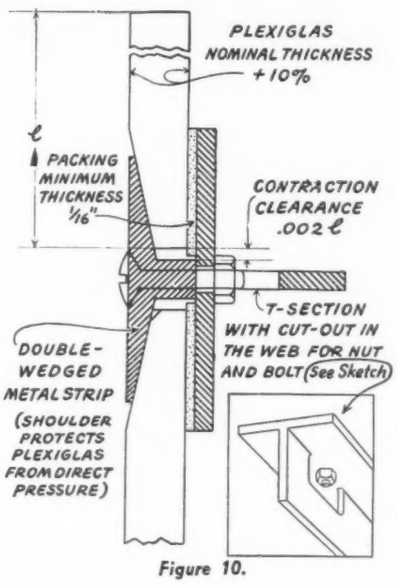


Figure 10.

The aluminum extrusion is in the shape of a very flat wedge so that either piece of Plexiglas may slide along it freely when expanding or contracting.

It also has a shoulder to prevent direct pressure on the Plexiglas. This shoulder bolts directly to the reinforcing member, a T-shaped beam with cut-outs in the web for the nut and bolt.

This type of installation is, of course, possible only with thicker Plexiglas sections where the edge of the sheet can be beveled. This beveling makes possible a flush outer surface, an advantage over the H-channel installation shown in Figure 5.

In practice, this type of mounting is often used only on one or two sides of a Plexiglas section, the other sides being mounted in a channel or by some other method.

NUT-AND-BOLT AND RIVET MOUNTINGS

Figures 11 to 15

When special considerations make channel and clamp mountings impractical, holes may be drilled in the Plexiglas for nut-and-bolt and rivet installations. To assure long service, special consideration should be given the following factors:

1. Use as many bolts or rivets as practical.
2. Distribute the total stress as equally as possible among these bolts or rivets.
3. The holes drilled in the Plexiglas should be sufficiently larger than the diameter of the bolt to permit expansion and contraction of the Plexiglas relative to the frame.
4. The holes in the Plexiglas should be concentric with the holes in the frame so that the greater relative expansion of the Plexiglas will not cause binding at one edge of the hole.
5. Use oversized tube spacers, shoulder bolts or rivets, cap nuts or some other device to protect the Plexiglas from direct pressure in installation.

RIVET AND SPACER INSTALLATION

Figure 11

This type of installation can be used with either a bolt or a rivet as the positive attachment. A tubular spacer protects the Plexiglas from direct pressure. Since this spacer is inserted after the Plexiglas is in position, assembly is quite simple.

A modification of this installation calls for the use of a long-shank screw or shoulder rivet. This modification would differ from the mounting shown in Fig. 13 in the holes drilled in the metal channel members. Here both holes are of the same diameter, in Fig. 13, one hole must be smaller than the other one.

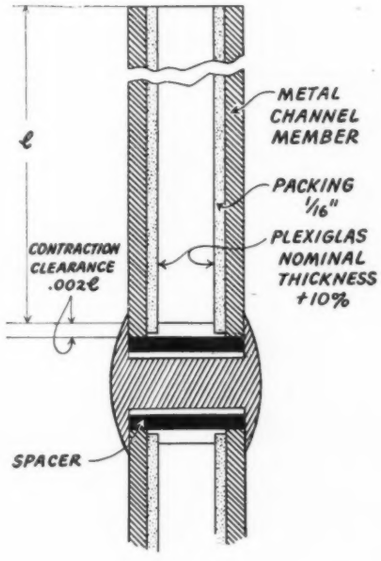


Figure 11.

The length of the spacer is calculated to allow for variations in the width of the channel, in the thicknesses of the Plexiglas and of the rubber packing.

Notice that contraction clearance is allowed around the bolt so that in case of extreme temperature changes, the Plexiglas will not bind and crack at one edge.

In this and other rivet and bolt installations, the recommended distance from the hole to the edge of the Plexiglas is the same as the recommended depth of grip in the channel installations.

BOLT AND SPACER INSTALLATIONS

Figure 12

Another method of mounting, which also makes use of a tubular spacer to protect the Plexiglas, is shown here.

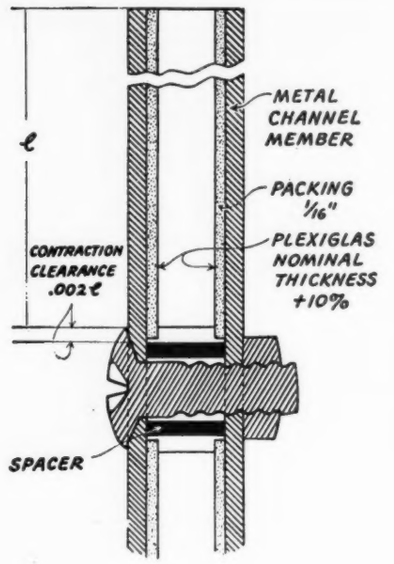


Figure 12.

In this case the spacer is equal to the inside width of the channel. This permits the use of countersunk screws as well as rivets, without reducing the protection to the Plexiglas.

It is somewhat more difficult to assemble than the method shown in Fig. 11, but satisfactory methods can be worked out to insert the spacers as indicated.

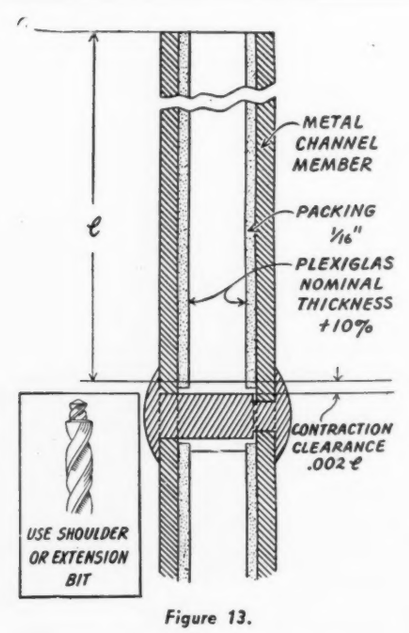


Figure 13.

SHOULDER RIVET INSTALLATION

Figure 13

To eliminate spacers, it is possible to use a shoulder rivet as shown in this sketch. A shoulder screw could, of course, be used in the same way.

This mounting requires that the rivet hole in one channel member be larger than the corresponding hole in the other member. Each member may be drilled separately and assembled later in a jig so that the holes are concentric. To drill both holes in a single operation (after the channel is assembled), there are a number of special bits available, known variously as shoulder, extension, subland, dual-cut, counterbore, combination, or step drills. The sketch illustrates one type of standard dual-cut bit.

ANNULAR RING AND BOLT INSTALLATION

Figure 14

Like Fig. 8, this type of installation is especially designed for hemispherical sections such as noses, gun turrets, and navigator's domes.

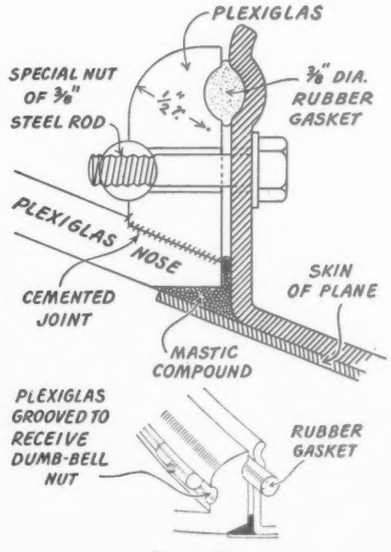


Figure 14.

A strip of thick Plexiglas is machined to the indicated cross-section and then formed to follow the circumference of the section. This circumference is also routed; on the inside, so that it will fit the annular ring; on the outside so, that it can be installed after all metal work is done. The ring is cemented to the section and the required holes drilled through it from below.

The dumbbell nut and the shape of the ring permit the section to rock slightly when the cabin is pressurized or when the Plexiglas expands or contracts. The rubber gaskets make the installation pressure tight. So that excess pressure will not be put on the ring, the bolt is threaded along only a small part of its length.

BOLT INSTALLATIONS FOR SMALL SECTIONS

Figure 15.

For small Plexiglas sections carrying very light loads, the simple installation shown here may prove satisfactory. It should not be used under any other conditions.

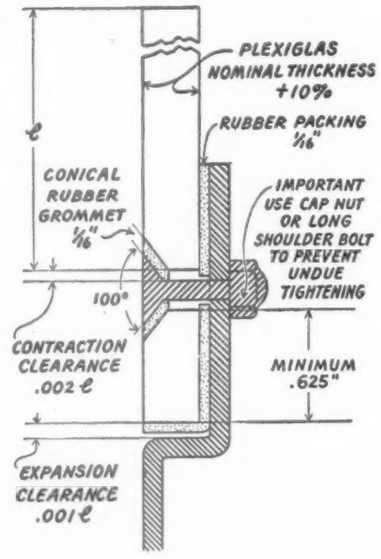


Figure 15.

In any event it should be used only when a cap nut, long-shank shoulder screw or some other device is included to prevent pressure on the Plexiglas. The conical rubber grommet does not offer sufficient protection for the Plexiglas.

Notice also that the head of the screw should have a flat angle. A sharper angle accentuates the wedge action of the screw head which tends to split the Plexiglas.

Fig. 2. Actual photograph of workman at the Douglas factory assembling the insulation to the wings with Speed Clips. Fig. 3. Workmen here are inserting the fuel tank in the wing.

New Gas Tank Insulation Fastener

By ELMER WHEATON

Assistant Research Engineer, Douglas Aircraft Company, Inc.

UNTIL QUITE RECENTLY it had been our custom to fasten gas tank insulation to the wings in our attack bombers by means of a special cement or mastic coating. While this method of cementing was satisfactory, we felt that it could be improved.

In discussing this possibility of improvement with the subcontractor we succeeded in securing from them an ingenious new Speed Clip that is snapped into position to hold this insulation and avoid the use of cement or mastic coatings. These Speed Clips are formed so that they may be snapped in place to hold the insulation firmly in position during and prior to the installation of the bullet-proof gas tanks.

We found the Speed Clip method faster and cleaner. This clip being made of 24ST aluminum with zinc chromate primer coating, holds the insulation to the wings indefinitely without corroding. Many man hours per plane have already been saved since the adoption of this new assembly method. The process of manufacture of these Tinnerman Speed Clips is equally as interesting as their application. Coils of 24ST aluminum strip stock are fed into high speed presses where they are formed in progressive stages, as shown in Fig. 4.

After the Speed Clips are formed they receive a coating of zinc chromate primer.

Fig. 5 shows how the clips are placed in racks to prevent distortion prior to final inspection and packing. The clips are given one hundred percent inspection on a test gage as shown in Fig. 5, then carefully packed in "egg crate" type boxes for shipment.

This is but one of the many ways in which subcontractors have employed their engineering and production facilities to the advancement of aircraft assembly.

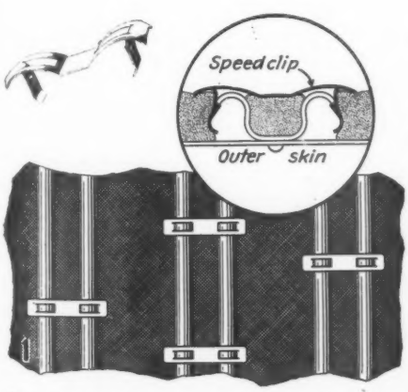
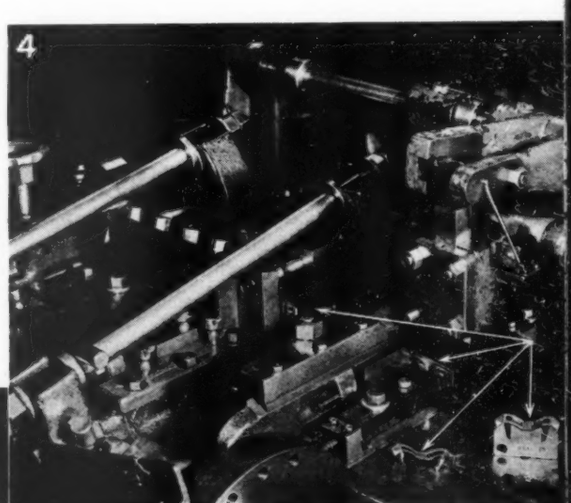


Fig. 1. Showing how Speed Clips are pressed over the insulation with the sheared barbs of the clips snapping over the edges of the "hat section" or channel supports to hold insulation snugly in place. Note how top surface of the clip is smooth, with corners turned down, to permit sliding the fuel tank into position without snagging.

Right: Fig. 4. Showing the aluminum strip leaving the press head where the shearing operations have taken place and entering the forming station where the clips are cut off and formed. Note the test gage which the operator uses constantly to check the Speed Clips for precision. Below: Fig. 5. The clips are placed in racks to prevent distortion prior to final inspection and packing. After inspection on a test gage, they are packed in "egg crate" boxes for shipment.



Designing Propellers to Meet Performance Requirements

Propeller installations are vital to the achievement of maximum airplane design performance. This article describes the factors that are considered in coordinating propeller design with airplane design.

By HAROLD H. WARDEN
Propeller Division, Curtiss-Wright Corporation

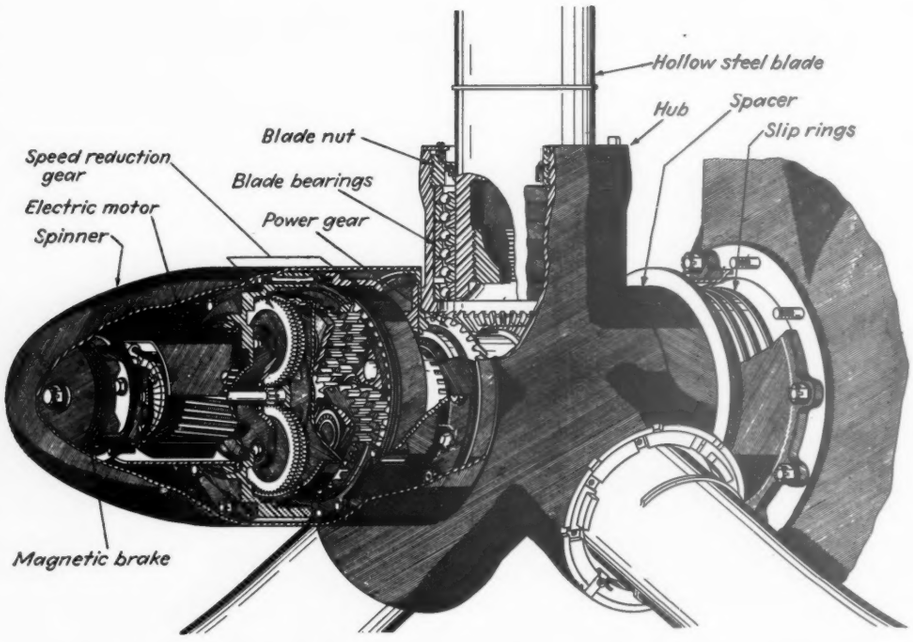


Fig. 1. Cut-away view of a typical three-blade steel Curtiss electric propeller.

WHEN an airplane manufacturer decides to produce a new type airplane, he has a definite goal in mind. The new aircraft may have to meet performance requirements of the Air Corps, the Bureau of Aeronautics, Civil Aeronautics Administration, an airline, or his own organization's design section. In any event, the new plane is being built for a special task, in addition to being an improvement over all previous aircraft of its class.

To achieve this objective, it is necessary that each part of the aircraft be as efficient and serviceable as is possible when taking into consideration such factors as weight and space. Inasmuch as the principal parts of the aircraft are considered, in addition to the aircraft structure itself, to be the engines and propellers, it is necessary that their characteristics and efficiencies under various operating conditions be considered during the early stages of design.

This article is primarily concerned with the correlation of propeller design with airplane design only.

In formulating the new aircraft design it is first necessary that the airplane manufacturer consider the aircraft requirements specified by his customer. This information includes facts on the type of aircraft (land plane, long range transport, pursuit, etc.), the order of importance of its performance in take-off, climbing, cruising or high speed, plus many other details pertaining to performance and cost.

Coordinating with his customer, the airplane manufacturer considers the power plant to be used and makes his selection, again bearing in mind the all-important items of performance and cost.

The next major item to be considered is the propeller, although in some cases it is necessary to select the propeller and engine simultaneously, since the efficiency and performance of each depends largely on the other. Quite frequently a current production propeller satisfies the airplane performance requirements. However, it is not unusual to find that a new model or even type of propeller is necessary. If the latter is necessary the design is made, usually in close cooperation with the engine and airplane manufacturers, to meet specified performance requirements.

PROPELLER SELECTION CRITERIA

The following data is therefore presented to the propeller manufacturer by the airplane designer so that he may aid in selecting the propeller most efficient for the aircraft that is to be constructed:

1. Type of airplane (land, boat, pursuit, transport, etc.)
2. Engine
   - A. Manufacturer.
   - B. Model.
   - C. Engine specification number.
   - D. Number of engines to be used on the airplane.
   - E. Propeller gear ratios.
   - F. Engine ratings at sea level take-off, and for climb, cruising and V_{max} at various predetermined operating altitudes.
   - G. Propeller direction of rotation.
   - H. Propeller shaft size.
   - I. Type of cooling.
3. Calculated approximate airspeeds of the proposed aircraft for the above engine ratings at their respective altitudes.

4. Maximum allowable propeller diameter — sometimes limited by ground or water clearance, or as in the case of a multi-engine airplane by proximity of one engine to another or to a structural part of the aircraft.
5. Type of propeller installation—tractor or pusher.
6. Order of performance importance—the order in which best performance is preferred, take-off, climb, cruise, or V_{max}.

With this information available it is possible for the propeller manufacturer to submit to the aircraft designer an aerodynamic propeller performance study showing the relative efficiencies of certain propeller models most satisfactorily meeting the design data requirements. This study gives the propeller diameter, solidity ratios, effective helical tip speed, and thrust values for specified and recommended gear ratios. The values of the foregoing, along with calculated propeller efficiencies, are based upon engine ratings at their respective predetermined operating altitudes. The total weight of each propeller also is listed.

Only such propellers are included in the final study that indicate, in one or more conditions, efficiencies that will give the required airplane performance.

In many cases additional factors must be considered, such as availability, cost, blade material, etc. The availability problem at present is one of major importance due to defense priorities. The cost is usually dependent on the type of propeller selected, material used, and whether the selected propeller is a model in current production. Blade material has a definite bearing on propeller selection inasmuch as hollow steel blades usually provide a weight advantage and are more resistant to stone and cinder nicks. This particular characteristic of steel blades is of great advantage on certain types of installations and operations. On some installations the propeller is so located as to receive stones and similar objects thrown by the landing gear wheels or nose wheel. This

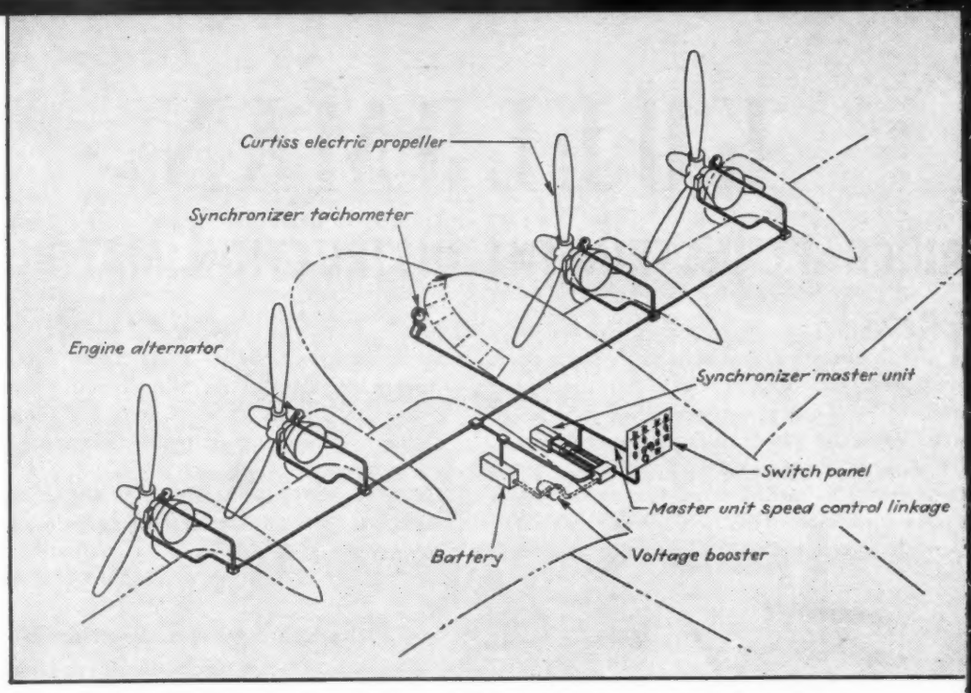


Fig. 2. Schematic diagram of a Curtiss electric propeller synchronizer control system.

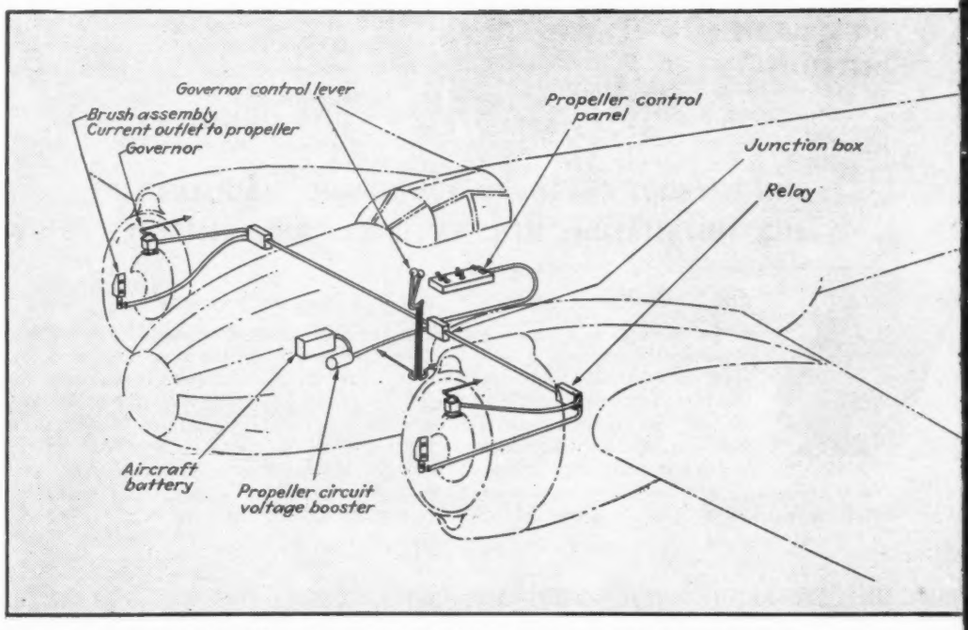
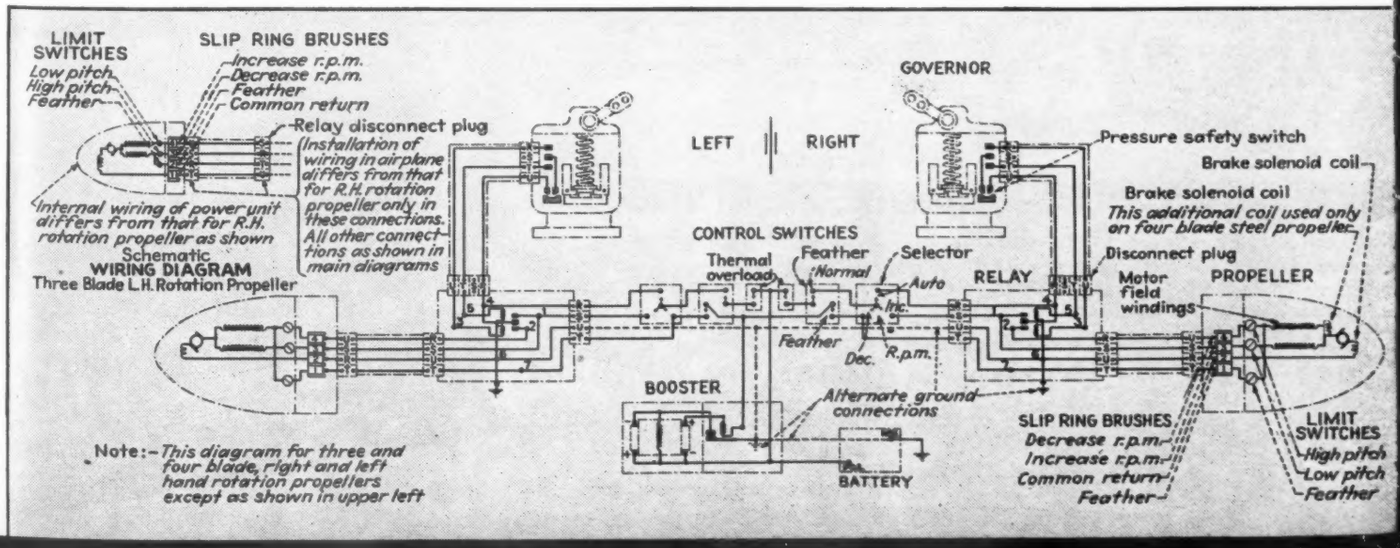


Fig. 3. Schematic installation diagram of Curtiss electric propeller governor control system.

Fig. 4. Schematic wiring diagram of the proportional governor of a twin engine Curtiss electric propeller installation.



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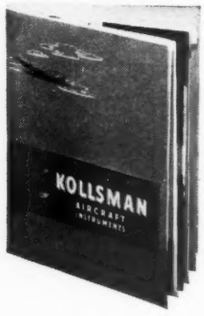

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can be of major importance, particularly if the airplane is to be operated from unimproved flying fields. A typical design of a Curtiss electric propeller with hollow steel blades is shown in Figs. 1 and 5.

From the results of the aerodynamic propeller performance study submitted by the propeller engineers, and bearing in mind other factors listed above, the aircraft designer proceeds to recalculate his airplane performance using the most suitable propeller efficiencies. As a result, he makes the final decision as to which model propeller will be specified.

If the propeller selected is a new design it must successfully pass a rigid test-stand endurance run, usually combined with an electric whirl calibration, to be approved by the CAA, Air Corps or Bureau of Aeronautics. Even though it is a current production model, or a new design installed on a certain model engine for the first time, it must meet vibratory stress tolerances for approved use, usually checked during trial flights on the "X" model or first airplane at initial installation.

In the case of the Lockheed P-38, (Fig. 6), it was found best that a three-bladed hollow steel propeller be used and that the left propeller should rotate counter-clockwise while the right propeller rotates clockwise.

On the Martin B-26 medium bomber (Fig. 7), both propellers are four-bladed hollow steel types and rotate clockwise. Due to the power output of these engines and the limited propeller diameter, it was advantageous to utilize the higher solidity ratio of the four-bladed propeller.

Now that the propeller itself has been selected it is necessary to determine the type of propeller control system most suitable to the aircraft under design. The Curtiss electric propeller installation provides great flexibility in this respect, inasmuch as any one of the three general control systems is readily adaptable to various types of installations. As will be noted (Figs. 3 and 4), a remarkably small amount of wiring and control items is required for the proportional governor system, which accounts for its wide usage in single- and twin-engine airplanes.

The automatic synchronizer control system, (Fig. 2), has certain definite advantages and is in more general use on multi-engine airplanes.

Another Curtiss electric propeller control system which is sometimes used is the remote control governor type. This system permits governor rpm selection by operation of an electric switch rather than by a governor lever control.

Any one of the propeller control systems can incorporate normal rate full-feathering, fast rate full-feathering (which requires the voltage booster shown in Figs. 2, 3 and 4) or no feathering feature at all. The feathering feature is usually provided in all installations except the single-engine type. To determine the specifications of the exact control items, it is essential that the engine governor drive ratio, its direction of rotation, and voltage of the electrical supply system be known.

The selection of a specific control system is determined by considering which is the most applicable and efficient for the weight and cost involved. As in the case of some multi-engine airplanes the synchronizer system may be preferred over the proportional governor, or remote control governor systems, due to the automatic synchronization feature. Since each installation presents its particular problems a complete control study is necessary.

On some airplanes reverse pitch is often desired to improve surface maneuverability. In the case of the larger type airplanes it is usually desirable to provide dual control panels for the pilot and flight engineer. Such variations from standard control systems are not unusual and can normally be incorporated into the control specifications.

Recent trends in new airplane development have been toward the use of ground test rigs which duplicate power plant installation details and permit testing in advance of installation on the airplane. Preliminary propeller blade vibration tests and control tests can be conducted as part of the test program on the ground rig.

FUNCTIONAL PROPELLER AUXILIARIES

It can now be assumed that the basic propeller and its controls have been designed and fabricated concurrently with the airplane and its engines, all of which are now ready for the initial propeller installation.

Aerodynamic spinners are almost invariably specified for liquid-cooled engines, inasmuch as the combination of the spinner and cowl increases the high speed efficiency by reducing the profile drag. The use of spinners is becoming more general for air-cooled engines, particularly on the high speed type airplanes, where improved engine cooling results. Figs. 6 and 7 illustrate typical spinner installations on the liquid-cooled and air-cooled engines, respectively.

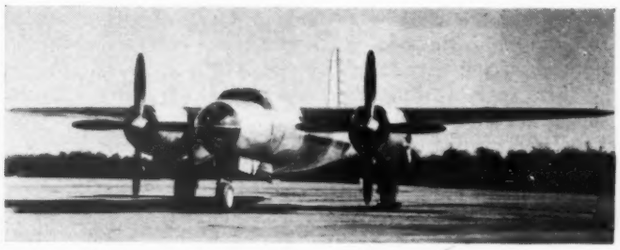
Blade shank cuffs, which recently have been developed, are specified for the most part on air-cooled engines in that their effect has been to increase the flow of air through the cowl at low speed, which aids in engine cooling

(*Turn to page 202*)

Fig. 5. A partially assembled three-blade hollow steel Curtiss electric propeller.

Fig. 6. Lockheed P-38 Interceptor equipped with Curtiss electric propellers.

Fig. 7. Martin B-26 medium bomber equipped with Curtiss electric propellers.



Producing Struts For the P-38

By WILBUR G. WOOD
Chief Engineer, Aircraft Strut Division, Menasco Manufacturing Co.

This article on the production of landing gear struts for the Lockheed P-38 interceptor is a dramatic illustration of the contribution which can be made to military aircraft production through subcontracting.

1 **Closeup of Lockheed P-38 showing features of main and nose struts of the landing gear.**

NOW ROLLING OFF the production lines in rapidly increasing numbers, the Lockheed P-38 interceptor must carry much of the load of defending American forces against bomber attacks. And all of the load in taking off or landing the P-38 is carried by the landing gear, which is of tricycle type. Both main and nose struts for the P-38 landing gear are manufactured by a subcontractor, to Lockheed designs. The P-38 landing gear is characterized by its simplicity and ruggedness. Not only does this assure reliability in operation, and simplify maintenance problems, but it helps speed manufacturing.

Basically there are but two parts to the P-38 main landing gear strut. These are the strut cylinder, which is attached to the airplane's structure; and the piston which operates in the cylinder and which carries the wheel at its lower end. Of course there are numerous auxiliary parts required for full operation. Contrasting with the extreme simplicity of this piston-cylinder combination is the rather common practice abroad of separating the strut into a load carrying member and a shock absorbing unit, resulting in many more parts. Some foreign designers also prefer to use heavy ring springs in the strut to carry compression loads, instead of relying on air pressure, as is standard American Practice.

MANUFACTURE IS SIMPLE BUT RIGIDLY CONTROLLED

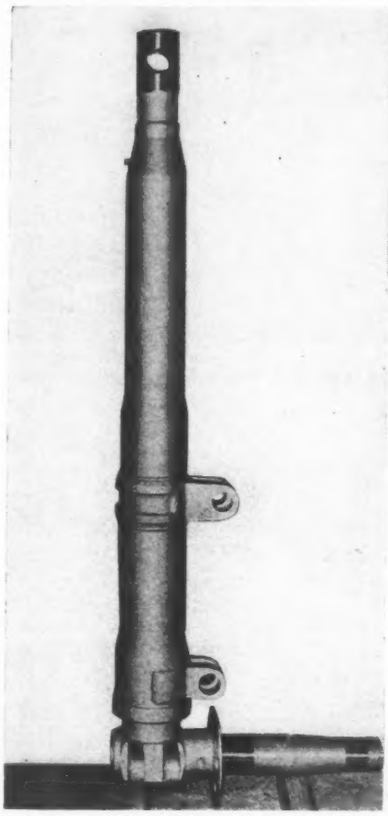
In order to justify its simplicity of design and manufacture the P-38 type strut must give unfailing service. This requires that manufacturing be conducted with extreme care and accuracy. Such manufacturing care must include precise heat treatment and unusual attention to inspection, in addition to a high quality of machine work. Two examples of operations other than machining will illustrate this. In heat treating and tempering the struts they are handled in special furnace equipment which protects them from room atmosphere and so practically eliminates scale formation. This contributes substantially to close control of dimensional tolerances. A further example is the practice of hard chrome plating the wearing surface of the piston tube. The piston is first turned on a lathe, then ground to close tolerances and finally buffed. Final operations are hard chrome plating to within .002 of specified diameter and buffing.

Importance of machinery to production of the P-38 struts is illustrated by comparing rough and finished weights of the major strut parts. The strut cylinder, a heavy seamless steel chrome molybdenum tube, weighs 168 lb. in the rough and only 45 lb. when finished, including the weight of two forced lugs which are welded on in the course of manufacture. The piston member is produced from a forging which weighs 126 lb. in the rough and only 28 lb. finished, including a torque flange which is welded on.

STRUT CONSTRUCTION

Since the P-38 landing gear is of tricycle type the main landing gear struts are located in rear of the C.G., being attached to the airplane's structure by a fulcrum. The struts are semi-cantilever, with drag braces running from about the mid-point of the strut, and side loads carried by brace struts extending up and outboard from the same mid-point fitting. Retraction is accomplished through a hydraulic cylinder operating on the drag strut, drawing the landing gear backward and up into wheel wells which are fully faired when the gear is retracted. These brace struts and the actuating cylinder are not produced by us, permitting us to concentrate all our production facilities on the strut itself.

There are two main chambers in the strut cylinder, the piston leg operating in the lower cylinder, which is filled with oil, while the upper chamber serves



2 A completed main strut for a P-38 landing gear.

as an air chamber. The piston has a diameter of 4 in. and a stroke of 10 in. Between the lower and upper chambers is an orifice plate which also serves as a stop when the piston is fully deflected. Oil fills not only the lower chamber, but extends 5 in. above the orifice plate into the upper chamber, the balance of the chamber being filled with compressed air. Forcing the oil through this orifice produces a "snubbing" action which works in either direction to take the initial shock, reduce rebound, and produce a smooth acting shock absorbing cylinder. Reserve oil carried in the upper cylinder is chiefly a safeguard against leakage, to insure against loss of oil which would uncover the orifice and impair proper functioning of the strut.

Overall length of the strut in normal position is 49½ in. from center of the upper fulcrum to center of the wheel axle. Maximum O.D. of the strut is 5⅜ in. Both the cylinder and piston are of chrome molybdenum steel which is heat treated to a strength of 180,000 psi. minimum. Bronze bearings are provided on the upper end of the piston and lower end of the cylinder so that sliding metal to metal contact is bronze against hard chrome plate or steel. Retention of the hydraulic fluid is by means of chevron type packing incorporated in the lower end of the cylinder just above the bearing. Proper alignment of the wheel axle is maintained by torque links connecting the piston with the cylinder.

The piston member is machined from a solid forging which incorporates a knuckle at the lower end. This knuckle is bored out to receive the wheel axle, which is pressed into the forging. The piston is precision machined, ground, and honed to a hollow cylinder closed at the upper end by means of a bronze piston head which also serves as the upper bearing. A torque plate is welded to the knuckle end of the piston, serving as a support for the brake mechanism.

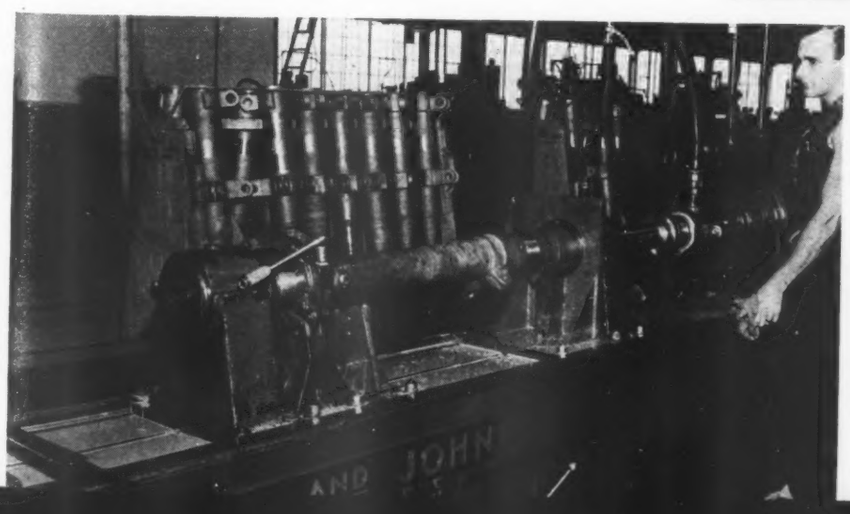
A sleeve is also screwed to the lower end of the cylinder to serve as a stop for the piston when in fully extended position. Below this sleeve is the cylinder packing, the lower bearing, and a retainer nut.

RUGGEDNESS OF CONSTRUCTION

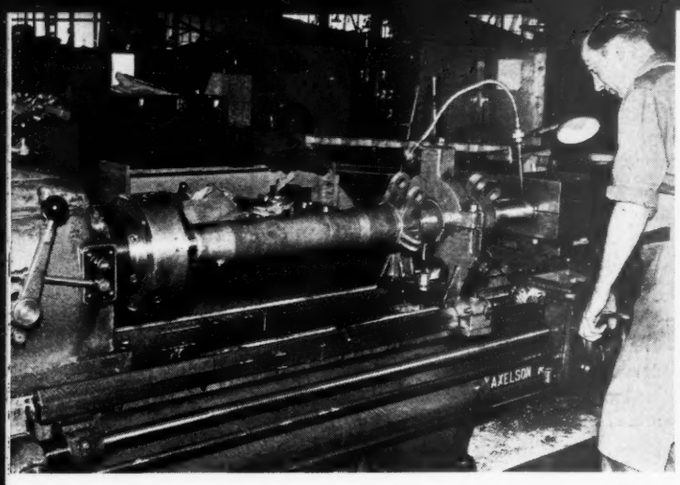
Representative of the best American practice in shock strut design, the P-38

3 Above: Special Monarch engine lathe equipped with profile bar for turning multiple O.D.'s.

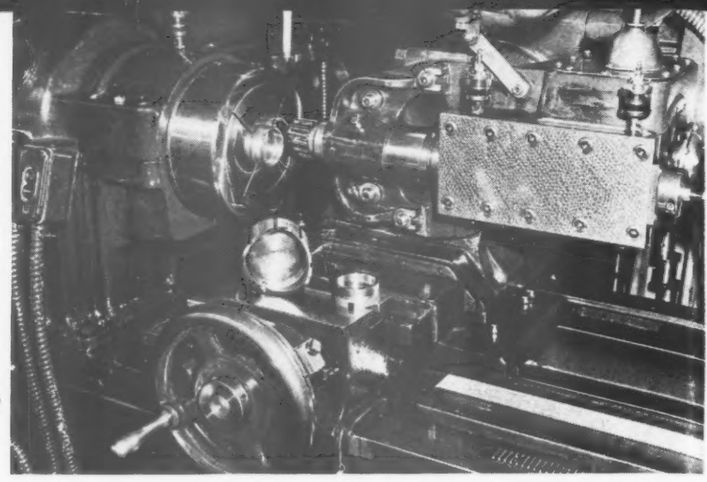
4 Right: Welding lug forgings to strut cylinder.



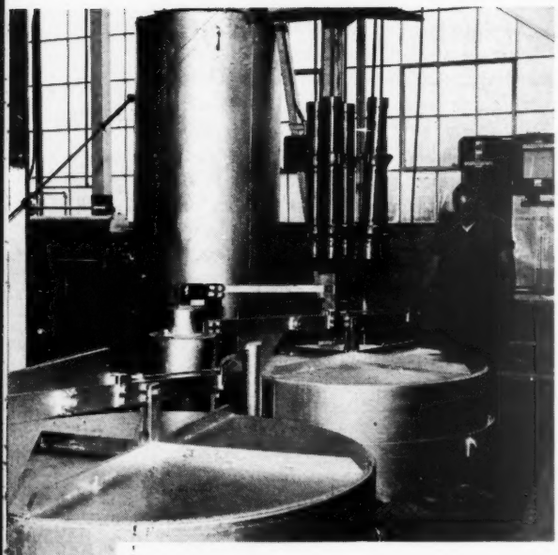
5 Left: Finish boring four diameters simultaneously in main strut on special Barnes machine.



6 **Finish boring the cylinder chamber in main strut on an Axelson engine lathe.**

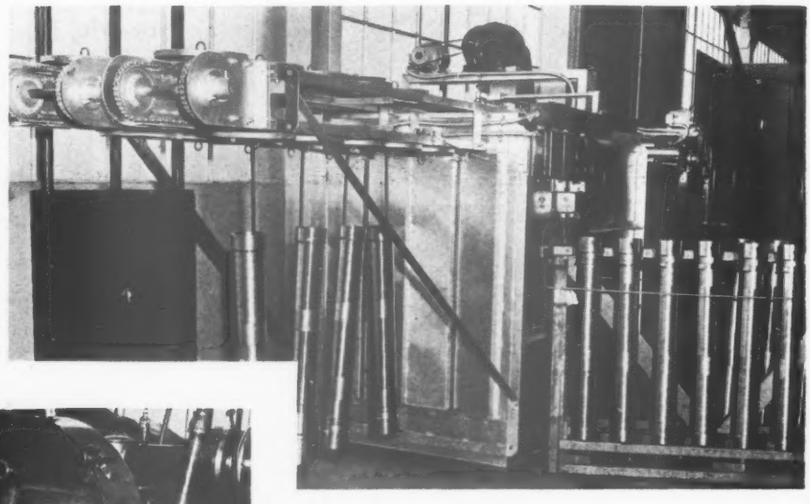


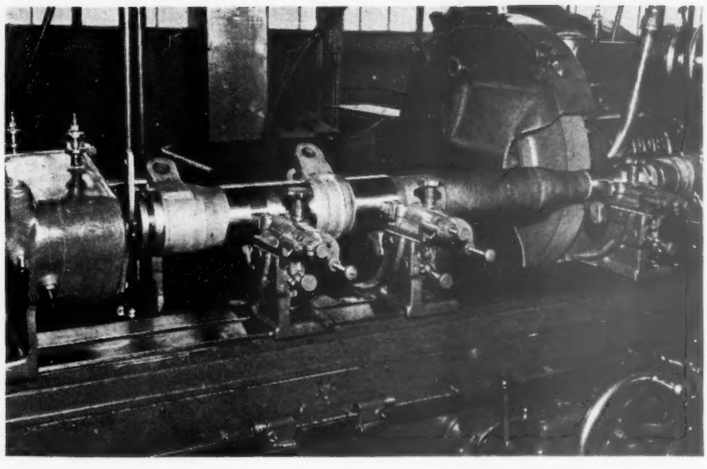
7 **Thread milling piston head and plug on a Lees Bradner thread mill.**



8 **Left: Heat treating department, which includes two electric furnaces, a quenching tank and work protecting hood.**

9 **Below: Strut cylinders, pre-heated to 300 deg. F. by an Acme automatic electric furnace, are delivered through automatic doors.**

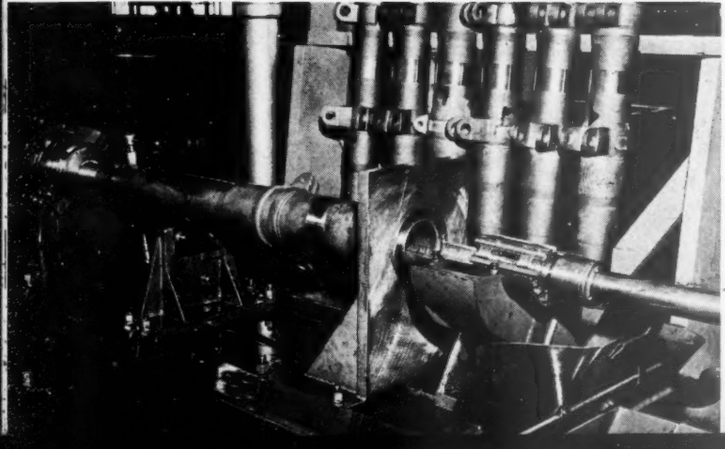


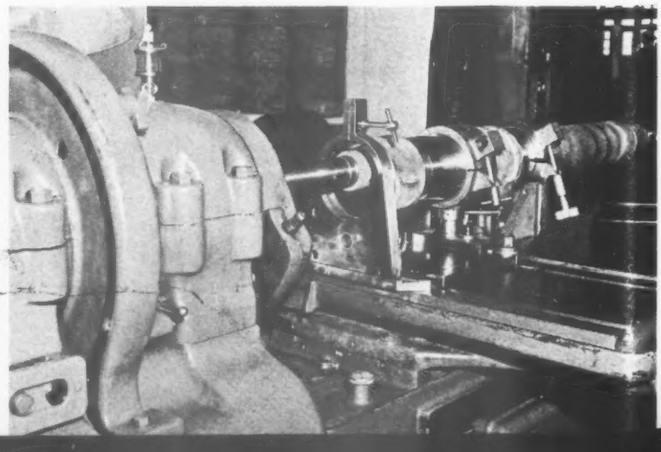


10 **Left: Grinding a main cylinder on a Landis machine.**

11 **Lower Left: Finish honing bores in main and nose strut.**

12 **Below: Grinding the packing gland chamber in the large end of main strut with Heald grinder.**





strut is quite conventional throughout. Its efficiency as a shock absorbing unit is the result of careful proportioning of the air and oil cylinders, and of the orifice between them, based on long experience and extensive testing. Not only is a strut of this design more readily adaptable to quantity production, and more serviceable in the field, as compared with more complex gears, but it is also less susceptible to damage from gun fire or shell fragments. We know of no case of such a strut having been penetrated by an enemy shell or bullet. In fact, the hardened steel tube of the strut, made strong for its work as a structural member, is fully equivalent to the armor plate normally used to protect vital parts of an airplane. And the shape of the strut cylinder would tend to deflect any bullet or fragment that did not strike squarely. Finally, even if the strut were pierced, it would still function serviceably without air pressure.

HOW QUANTITY PRODUCTION IS ACHIEVED

In achieving quantity production on P-38 struts, the subcontractor has built and equipped a complete new factory designed specifically for this work. This plant is half again as large as the portion of the factory formerly devoted to engine manufacture. Furthermore, under the pressure for all-out strut production, we have converted a large part of the engine plant to strut work.

To illustrate the scope of the manufacturing processes involved, there follows a brief description of the operations performed on the main strut cylinder.

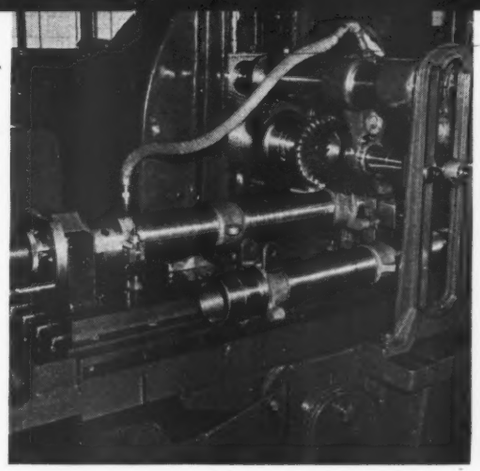
The upper end of the strut tube is reduced by swaging to approximately half its original diameter. Then both ends of the tube are rough-faced to approximate length.

The cylinder O.D. is turned on a special Monarch engine lathe, equipped with a contour plate attachment which controls the tool in cutting 12 different diameters, and tapers between them, along the length of the cylinder. This machine performs both rough and finish cut operations. Rough cut for this operation is about $\frac{1}{16}$ in. and the finished cut about $\frac{1}{32}$ in. The lathe has a 22 in. throw and 72 in. bed. The cutter is set against the work by means of a cam follower held against the profile bar by an air cylinder. Following this, the upper end of the cylinder is drilled for location of oil and air filler plug.

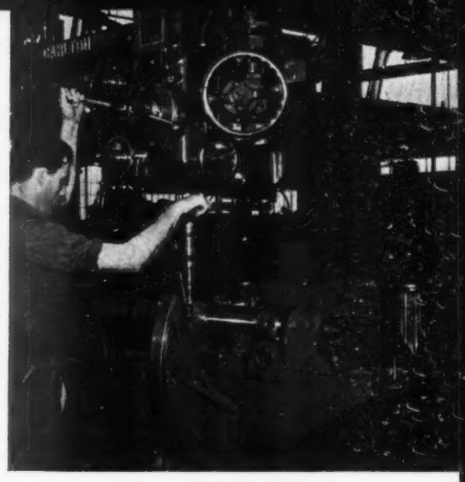
Two forged fittings are welded to the cylinder with a Lincoln arc welder. On the upper side of the cylinder is a ring fitting with two sets of lugs, one extending forward which carries the lower end of the drag brace strut and the other extending laterally to the outboard side to carry the side brace strut. This forging is slipped over the cylinder and welded into place. The lower fitting is a strap type, extending about halfway around the strut, and carrying lugs for the attachment of the upper torque link. This is welded in place while positioned in a precision jig. The air valve and fluid filler boss is also welded in place near the upper end of the cylinder.

Close metallurgical control is exercised over the welding operation, maintaining constant check on the composition of the metal and welding rod, heat of weld, etc. After tack welding, the cylinders are preheated to 300 deg. F. in an automatic electric oven and are then mounted in a power rotated welding jig which may be positioned to pro-

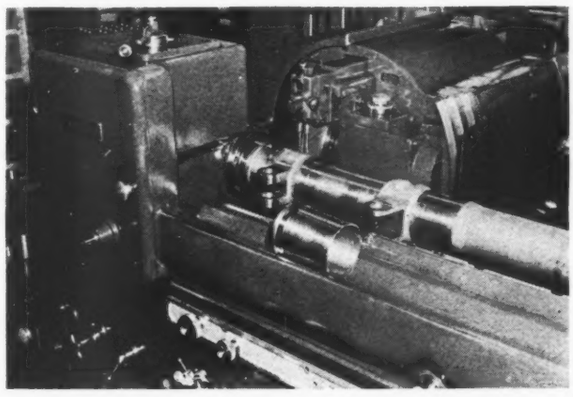
(*Turn to page 200*)



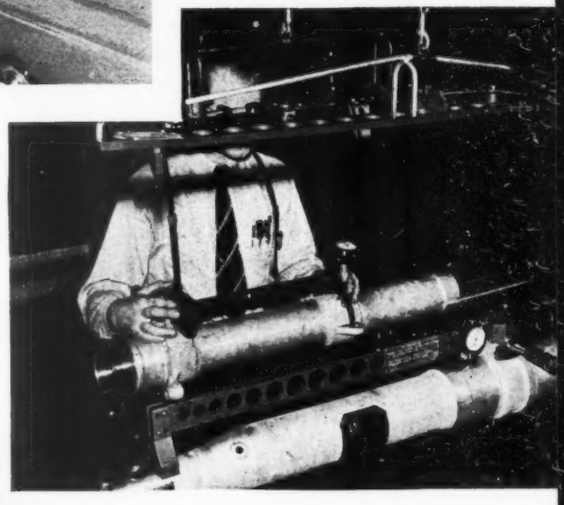
13 **Milling both sides of lugs simultaneously at one end of nose strut with a Milwaukee simplex production mill.**



14 **Finish drilling main cylinder with Carlton radial drilling machine.**

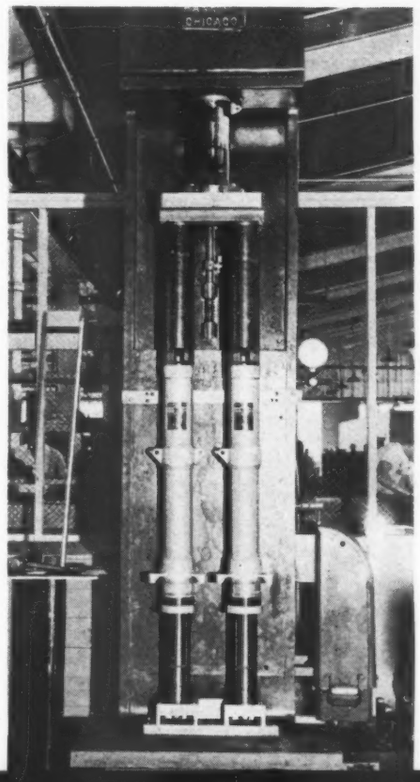


15 **Left: Threading main cylinder on Ex-Cell-O grinder.**



16 **Right: Final dimensional inspection of main and nose strut cylinders.**

17 **Below: Nose strut being given run in test on Hannifin press.**



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Design Charts for Tubes Subjected to Bending

WHILE WORKING on the stress analysis of landing gear shock absorbers, the writer became impressed with the thought that something could be done to simplify the stress analysis of tubes subjected to bending. The idea of selecting a tentative size; of computing its section modulus; of computing its fiber stress; of determining its modulus of rupture and of computing its margin of safety, only to have to repeat the entire process until a size was determined which yielded a small positive margin of safety, seemed incongruous. A more direct approach was needed. For a given bending moment, heat-treatment and tube diameter, there is only one wall thickness that will yield a zero margin of safety. The method outlined below enables the engineer to determine this wall thickness without calculating the section modulus or fiber stress and without determining the modulus of rupture. For any wall thickness other than that corresponding to zero margin of safety, one may readily determine the margin of safety or the stress ratio.*

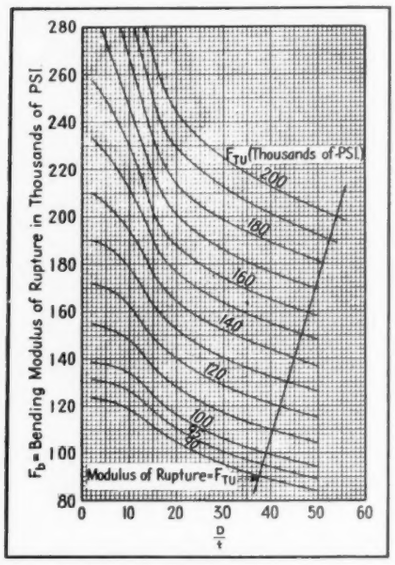


Fig. 1. Bending Modulus of Rupture—Chrome Molybdenum Steel Tubing.

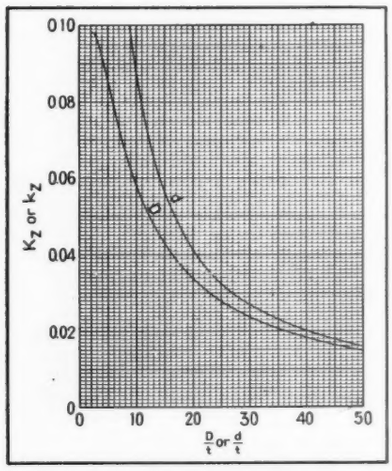


Fig. 2. Chart for determining the section modulus of tubes of the same diameter but of varying wall thicknesses.

As many engineers now entering the aircraft field may not be familiar with the details of aircraft stress analysis, a brief discussion seems in order. The following terminology has been used:

D = Outside diameter of tube.
d = Inside diameter of tube.
F_b = Allowable bending stress (modulus of rupture).
f_b = Design bending stress = $\frac{M}{Z}$
K_z = Constant for determining section modulus of tube. See Fig. 2 and "Eq. (4.)"
k_z = Constant for determining section modulus of tube. See Fig. 2 and "Eq. (5.)"
M = Bending moment for which tube is being designed.
M' = Bending moment which tube selected is capable of resisting.
(*M.S.*) = Margin of Safety.
psi = Pounds per square inch.
R_b = Stress ratio = $\frac{f_b}{F_b}$
t = Wall thickness.
Z = Section modulus.

Represented by Fig. 1, is a family of curves for tubular steel members having various heat-treatments. The bending modulus of rupture is given as a function of $\frac{D}{t}$. When $\frac{D}{t}$ is equal to 2, the member is a solid bar.

From a glance at these curves it will be seen that as the value of $\frac{D}{t}$ gets smaller, the allowable bending stress, (modulus of rupture) increases. It may considerably exceed the ultimate tensile or compressive strength of the material. This increase results from the more remote fibers yielding and the adjacent fibers nearer the neutral axis picking up more stress than would be the case if stress had remained proportional to strain.

As $\frac{D}{t}$ gets larger and larger, the wall thickness becomes relatively quite thin and wall instability may appreciably reduce the allowable bending stress. Thus for large values of $\frac{D}{t}$ the allowable bending stress may be appreciably less than the allowable ultimate tensile or ultimate compressive stress.

The modulus of rupture is a fictitious fiber stress. It is the fiber stress that would exist, if at the instant of failure, stress had remained proportional to strain and wall instability had played no part in the failure. It is a handy device that permits us to use formulas that are based on Hooke's law, for stresses beyond the proportional limit and for cases where failure is due to local elastic instability.

The usual procedure in designing a tubular member to withstand a known bending moment is to select a size, a material and heat-treatment which

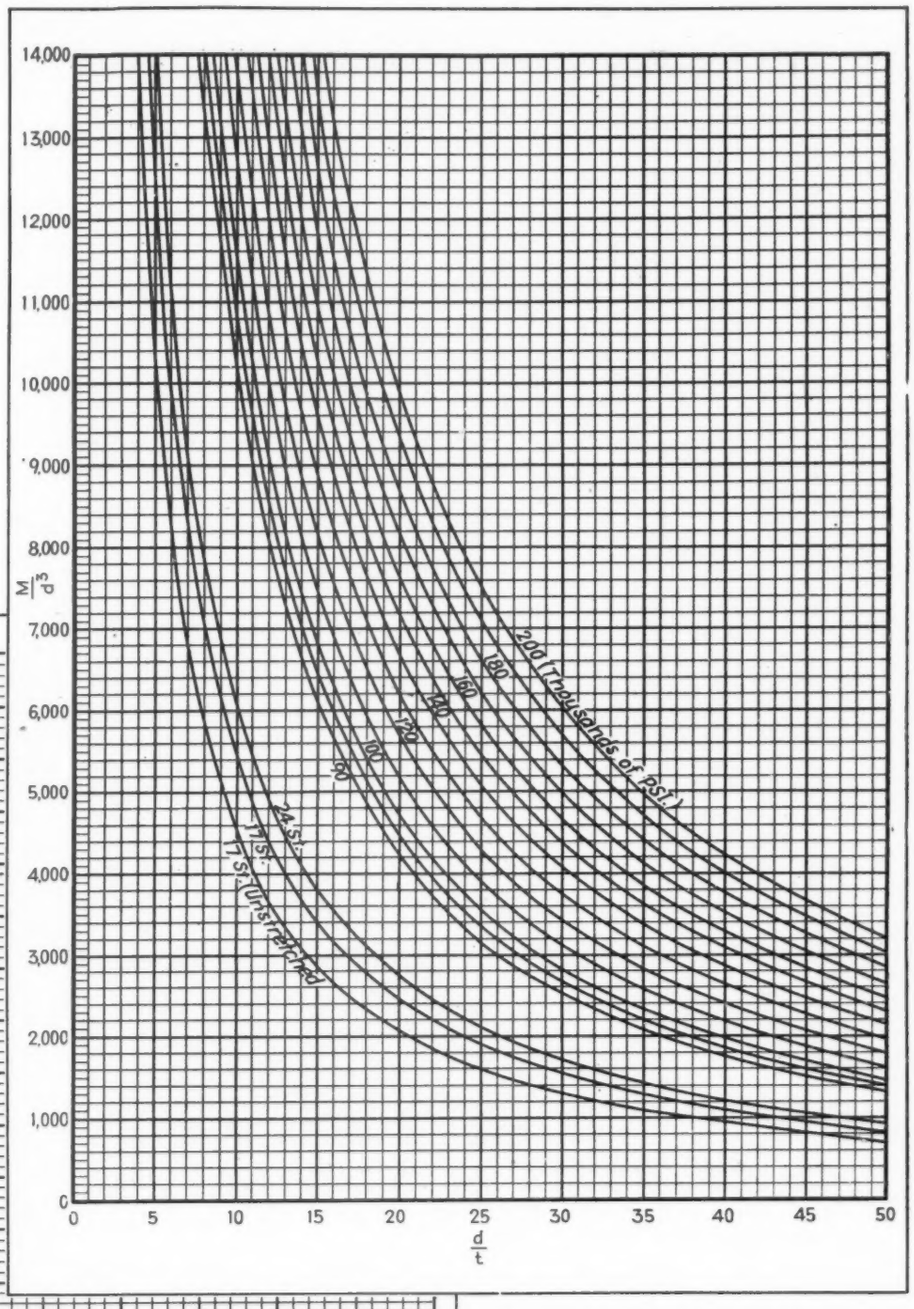
*F. R. Shanley and E. I. Ryder, Stress Ratios—The Answer to the Combined Loading Problem, AVIATION, June 1937.

Walter C. Clayton

Design engineers will welcome this simplified method of determining wall thickness of tubes subject to bending to yield a desired margin of safety. This method eliminates the necessity for computing section modulus, fiber stress, and modulus of rupture.

By WALTER C. CLAYTON

Chief Engineer,
Curtiss Wright Technical Institute



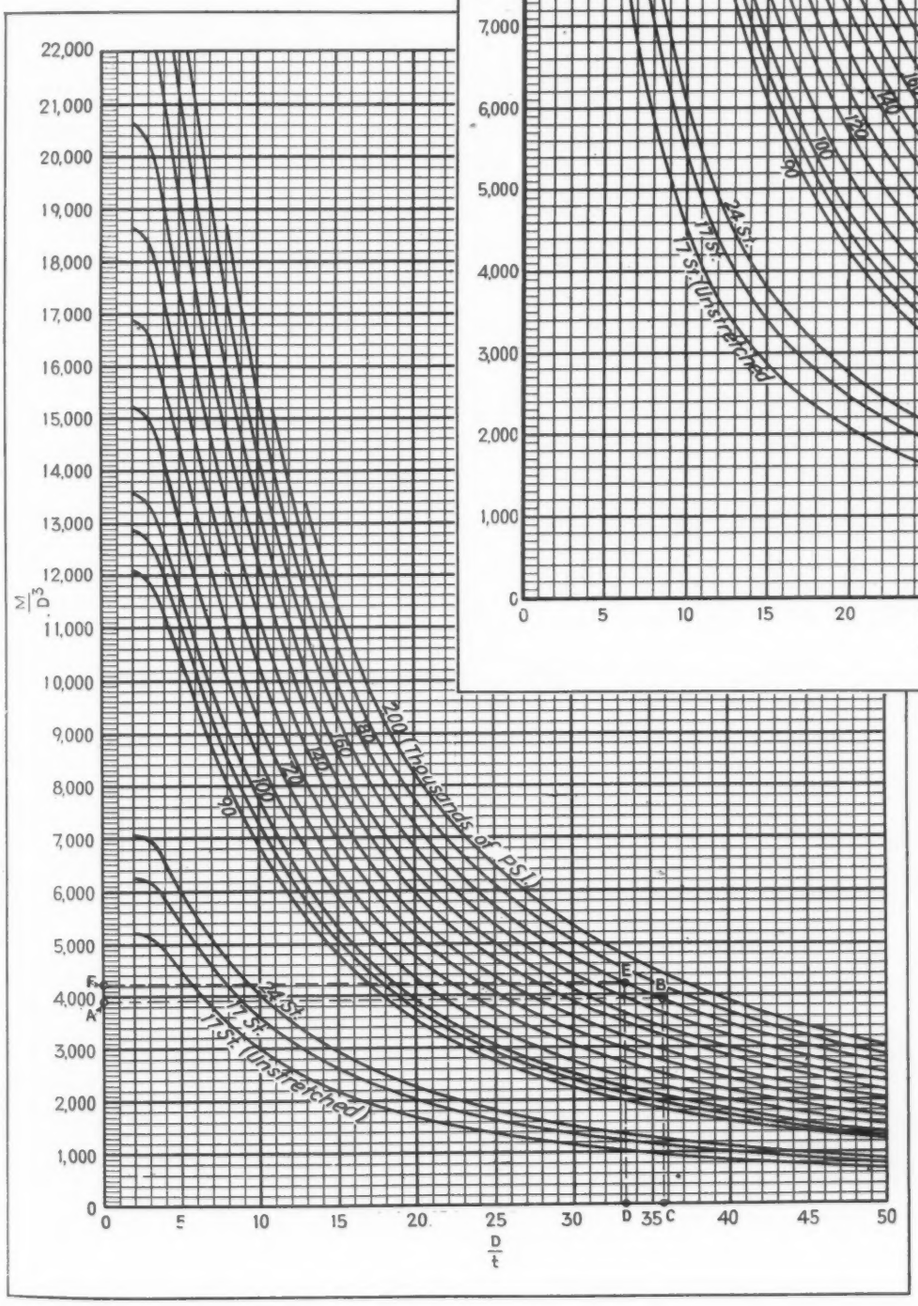


Fig. 4. Above: Stress analysis chart for tubes with given inside diameter. This chart and Fig. 3 are obtained by multiplying the ordinates of the curves in Fig. 1 by those in Fig. 2.

Fig. 3. Stress analysis chart for tubes with given outside diameter. This chart gives the factors for determining the wall thickness required for zero margin of safety, or for determining the margin of safety and stress ratio obtainable from a tube of given wall thickness.

would appear to be suitable. One may now compute the section modulus of the member, using either tables (where available) or the formula:

$$Z = \frac{\pi}{32}\left(\frac{D^4 - d^4}{D}\right) \qquad (1)$$

The computed bending stress may be determined from the equation

$$f_b = \frac{M}{Z} \qquad (2)$$

Knowing the diameter and wall thickness of the tube, the numerical value of $\frac{D}{t}$ can be obtained. Referring to Fig. 1, the allowable bending modulus of rupture in thousands of pounds per square inch can be found. This is given as F_b. The margin of safety is:

$$(M.S.) = \frac{F_b}{f_b} - 1 \qquad (3)$$

It must not be negative, as this would indicate an unsafe structure. It must not be a large positive value as this would indicate a needlessly heavy structure. After obtaining the margin of safety, the designer must reconsider his original guess of the size of tube required. He may now select another size to obtain a member of adequate strength but not excessively heavy. This trial and error, or guess and check procedure, is time consuming and frequently results in the selection of a member that is needlessly heavy.

For a given diameter tube, it would be desirable to be able to compute directly the wall thickness necessary to give a zero margin of safety. Such a procedure is outlined in the following paragraphs.

The section modulus of similar tubes $\left(\text{same } \frac{D}{t}\right)$ varies as D^3. The section modulus of tubes of the same diameter but having different wall thickness varies as a function of $\frac{D}{t}$. In place of "Eq. (1)" we may therefore write:

$$Z = K_z D^3 \qquad (4)$$

The variation of K_z with $\frac{D}{t}$ is represented by the lower curve of Fig. 2. If desired, the section modulus can be computed using the inside diameter. This at times is convenient. The formula then becomes:

$$Z = k_z d^3 \qquad (5)$$

The value of k_z can be obtained from the upper curve of Fig. 2.

Both f_b and F_b are also functions of $\frac{D}{t}$. This suggests that the curves of Fig. 1 and of Fig. 2 might be combined in such a manner as to facilitate a more direct procedure in determining the size of tube desired. Actually, by multiplying the ordinates of the curves in Fig. 1 by the ordinates of the curves in Fig. 2 the curves of Figs. 3 and 4 are obtained. The ordinates in Fig. 1 represent pounds per square inch of stress which can be expressed: stress $= \frac{M}{Z} = \frac{M}{K_z D^3}$. The ordinates in Fig. 2 represent a dimensionless constant. The product of the ordinates of Figs. 1 and 2 is: $\frac{M}{K_z D^3}(K_z) = \frac{M}{D^3}$ which is plotted against $\frac{D}{t}$ for the various heat-treatments. Provided that the tube is of reasonable proportions, $\frac{M}{D^3}$ will have a numerical value of between 1,000 and 20,000. The results of using Fig. 3 are identical to those of using Fig. 1, but much time is saved.

The use of the curves can best be illustrated by examples.

Example:

Given: A piston tube of a cantilever landing gear shock absorber having a bending moment of 250,000 in.-lb. It is desired to make this tube 4 inches in diameter and in order to keep the weight down, the tube will be heat treated to 180,000 *psi* ultimate tensile stress.

Wanted: (a) The required wall thickness for zero margin of safety.

(b) The margin of safety and the stress ratio, assuming that it is decided to make the wall thickness 0.120 in.

Solution:

(a) $\frac{M}{D^3} = \frac{250{,}000}{4^3} = 3{,}910$

This point is designated as A on the $\frac{M}{D^3}$ scale of Fig. 3. Draw a horizontal line and extend it until it intersects the 180,000 *psi* curve at B. Drop a vertical line from B to the $\frac{D}{t}$ scale at C. The value of $\frac{D}{t}$ for point C is 35.7. The required wall thickness for zero margin of safety is $\frac{D}{\left(\frac{D}{t}\right)} = \frac{4}{35.7} = 0.112''$.

(b) For a wall thickness of 0.120 in. the value of $\frac{D}{t} = \frac{4}{0.120} = 33.3$. This is point D on the $\frac{D}{t}$ scale. Draw a vertical line up to point E on the 180,000 *psi* curve. From E draw a horizontal line to F on the $\frac{M}{D^3}$ scale. Point F represents the value of $\frac{M'}{D^3}$, where M' is the bending moment that can be resisted when the wall thickness is 0.120 in. Its value is 4,210.

The margin of safety is determined as follows:

$$(M.S.) = \frac{\left(\frac{M'}{D^3}\right)}{\left(\frac{M}{D^3}\right)} - 1 = \frac{4{,}210}{3{,}910} - 1 = 0.077 = 7.7\%$$

When the problem involves stress ratios, the stress ratio $R_b = \frac{f_b}{F_b}$ may be expressed as $R_b = \frac{\left(\frac{M}{D^3}\right)}{\left(\frac{M'}{D^3}\right)} = \frac{3{,}910}{4{,}210} = 0.929$

In considering tubular members of relatively large diameter and thin wall which are machined inside and out, the matter of manufacturing tolerances should be given careful consideration. The specified tolerances for seamless tubing insure against undersized members. The designer must insure against undersized machined tubes. Let us assume in the case above, that the outside diameter is to be held to tolerances of $+\,0.000''$ $-\,0.005''$ and that the inside diameter is to be held to $\pm$ 0.010 in. It is readily seen that the wall thickness could be 0.015 in. less than the nominal thickness. To insure against a negative margin of safety the nominal wall thickness would have to be $0.112'' + 0.015'' = 0.127''$. Similarly if a margin of safety of 7.7 percent or a stress ratio of 0.929 is desired, the nominal wall thickness should be $0.120'' + 0.015'' = 0.135''$.

It frequently becomes necessary, as in the case of a shock absorber cylinder, to maintain the bore of the cylinder and make the outside diameter that which is necessary to insure adequate strength. In this case we are concerned with d, the inside diameter instead of D, the outside diameter. We may prepare a similar set of curves to those shown in Fig. 3 in which $\frac{M}{d^3}$ is plotted against $\frac{d}{t}$. These can be used in identically the same manner as that illustrated above. Such a set of curves are contained in Fig. 4.

Example:

Given: A cylinder with a bending moment $M = 250{,}000$ in.-lb. made of alloy steel, heat-treated to 180,000 *psi* and having an inside diameter equal to 4 in.

Wanted: The required wall thickness for zero margin of safety.

Solution:

$$\frac{M}{d^3} = \frac{250{,}000}{4^3} = 3{,}910$$

From Fig. 4 the value of $\frac{d}{t} = 38.8$

Therefore the required t for zero margin of safety is equal to

$$\frac{4}{38.8} = 0.103''$$

The outside diameter would be: $4'' + 2(0.103'') = 4.206''$

(Turn to page 205)

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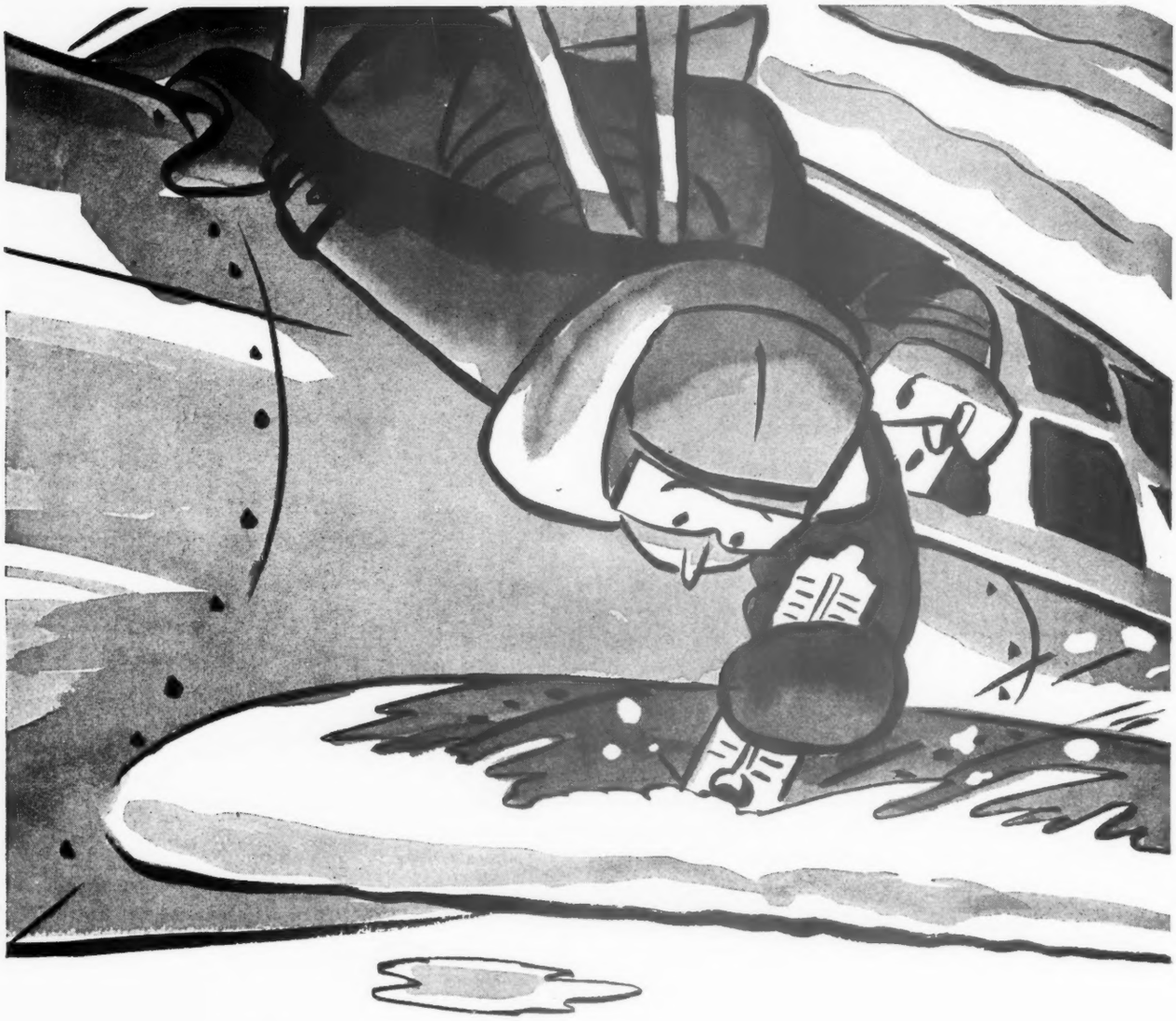

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Cleaning Alclad For Production

Mass production spotwelding is advanced by a new method for cleaning Alclad parts.

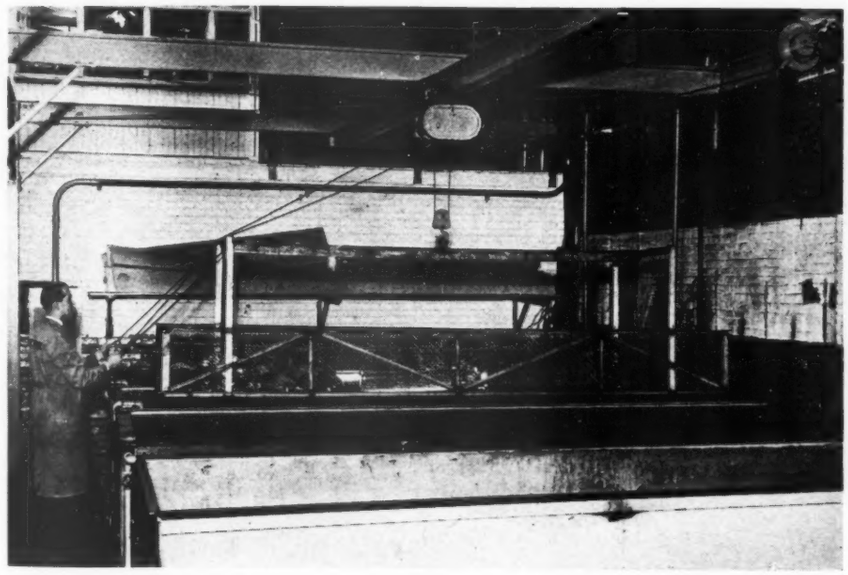
By **FRED MORRIS,** *Engineering Department, Fleetwings, Inc.*

VERSATILE is a good word to use when speaking of Fleetwings production and design. A review of the contracts underway shows that three types of construction are being used: spotwelded stainless steel, riveted aluminum alloy, and spotwelded Alclad. Almost 30 percent of the spotwelding being done is on aluminum alloy parts for control surfaces.

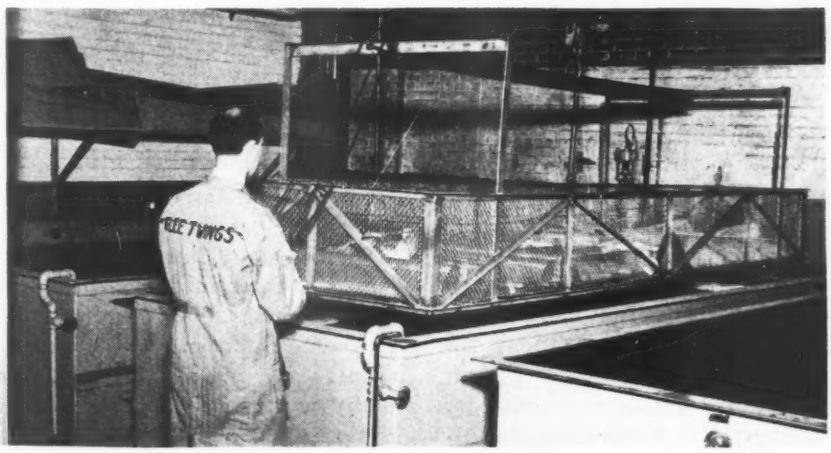
All of the Fleetwings developments in Alclad spotwelding have been accomplished since Navy approval of Fleetwings equipment was received in 1940 with a report commending the consistency of the welds which showed a maximum deviation in strength of only 8.3 percent. Since that time many methods have been developed to help Fleetwings to maintain its record deliveries of aircraft control surfaces.

METHOD OF PREPARING SURFACE

One phase of the problem of production spotwelding of Alclad involved the development of a method of preparing the surfaces of the metal to secure a satisfactorily low surface resistance between the parts to be welded, and to do it consistently. A satisfactory method was developed and a number of companies have been furnished the data in the past few months. The details are set down here for others who may find them useful in the furthering of our national defense.



In Fleetwings cleaning operation, parts to be dipped are placed in a long basket suspended from overhead traveling crane running on the girder flanges. In this manner, basket and contents can be transferred easily from one tank to another.



The basket, into which the parts to be cleaned are put, is made of stainless steel so that it will resist the nitric acid used in the process.

Where quantities are small, the old reliable method of preparing the surface with a rotating wire brush is suitable. However such a method is too slow, and requires too much manpower for today's requirements, and involves the human element which results in variable degrees of cleaning. Therefore, chemical cleaning processes were investigated to speed up output of parts for spotwelding. Some chemical processes did not give consistently good

(*Turn to page 205*)

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There is a daily average of 40 flights by three airlines at Love Field, Dallas — headquarters for Braniff Airways, terminal for American Airlines and Delta Airlines. 100% of these planes have installations of Cuno Filters.

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For you have been practically unanimous in your choice of Cuno.

Cuno was in on the ground floor of aircraft engine lubrication. Engine builders recognized it as an opportunity to insure further against failure due to contaminated fluid or clogged fluid lines. And in the succeeding years, Cuno engineers have satisfied many other aviation requirements.* Today, the demands of engine and aircraft builders are largely responsible for the tripling of Cuno's manufacturing facilities.

* Among them the Cuno self-cleaning filter. See illustration at right.

From Drafting Room to Maintenance Shop

The Cuno engineer serves the industry in many ways . . . designing filters for individual applications . . . aiding aviation designers in building Cuno Filters into their blueprints . . . servicing the ultimate operators of the aircraft.

That is why Cuno engineers are familiar figures in drafting rooms, near assembly lines, on proving grounds, in airport maintenance shops.

If your responsibility is the protection of lubricated or fluid-controlled parts, the selection of a Cuno Filter will be in line with the entire industry's best judgment.

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In this space, Cuno, conforming to the practice of previous ads, had intended publishing a map and certain information regarding the location, identification and facilities of this airport. In the interest of withholding information which might be construed as valuable in a military sense, we have removed the map and text from this panel.

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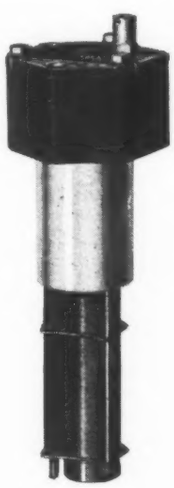

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Salvaging Power In Engine Testing

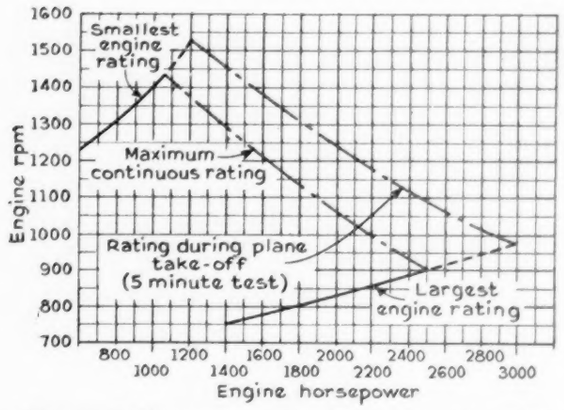


Fig. 1. Typical curves showing range of engine horsepowers and speeds for which testing equipment should be designed.

The problem of efficiently harnessing energy developed in testing aircraft engines is essentially one of how to pump power from a varying-speed source into a constant-frequency system. This solution utilizes a slip coupling between driver and generator.

By G. E. CASSIDY

Industrial Engineering Department, General Electric Company

WASTE AND DISREGARD of value in industrial processes, even though sometimes seemingly necessary, will sooner or later be eliminated by a progressive management.

Thus it was that a large airplane engine manufacturer not long ago stated, in substance, "Our present methods of testing are not satisfactory. Cannot a system of testing be devised which will be economically efficient and which will make the loading of large engines easy and simple?"

He continued, "Engine testing is a very important part of airplane engine manufacture. Each engine must be run under load for considerable periods. The only schemes now known for production loading of engines are calibrated propellers, water brakes, electric brakes, and similar devices, all of which involve disposal of the engine power by complete wastage. The fuel consumed, obviously great, accomplishes no useful purpose other than to permit testing the engine. Furthermore, engines are growing in size to the extent that the present power-dissipating schemes of testing are beginning to present some difficult problems."

The following system of testing was developed in answer to the foregoing query. Since the first installation of this character, consisting of two testing units, seventy-five additional units have been or are in the process of being installed. Some of these additional units differ in detail but they all involve the same problems and the same scheme of operation described in this article.

To arrive at the required answer, there are three logical steps of thought: (1) determination of the characteristics of the engines to be tested, (2) determination of a means of utilizing the power produced by the engine while being tested, and (3) determination of a system which will tie (1) and (2) together.

(1). Excepting unusual manufacturing set-ups, the testing system will be more useful if it can accommodate a range of engine sizes. In order to be specific, assume that it is required to test engines designed for the operating ranges shown in Fig. 1—that is, to test any engine within the range indicated as the largest and the smallest engine. From these curves, it will be noted that the engines operate at various speeds and horsepowers. Also, that for a given engine the horsepower output changes rapidly with changes in speed. Not apparent from the diagram, however, are the requirements that any testing equipment must be capable of driving the engine as well as absorbing power from the engine and must be capable of operating in either direction of rotation.

(2). In regard to the matter of utilizing the power produced by the engines, there is but one answer—namely, to pump the power into the power system of the manufacturing plant. This introduces a new factor because it involves the public utility which supplies power to the manufacturing plant. When a small number of engines is operating, the effect is to reduce the public utility's input to the plant. When a large number of engines is running, a condition may be reached where the engines actually pump power back into the utility system. It is, of course, the function of a power company to sell power. This form of testing, therefore, presupposes hearty cooperation between the power company involved and the engine manufacturer.

(3). Passing to the third consideration, that of tying the engine and the power system together, it will be seen that the problem is essentially that indicated in the title of this article—namely, the problem of tying together a constant-frequency power system and the equivalent of a varying-frequency power system.

There are a number of ways of attacking the problem. For example, the engine might be connected to a d-c

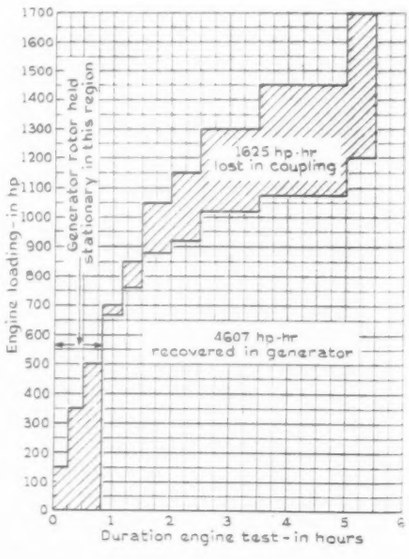


Fig. 3. Graph showing that of the total of 6,232 hp.-hr. delivered by an engine during a test run, 4,607 hp.-hr. were recovered in the generator.

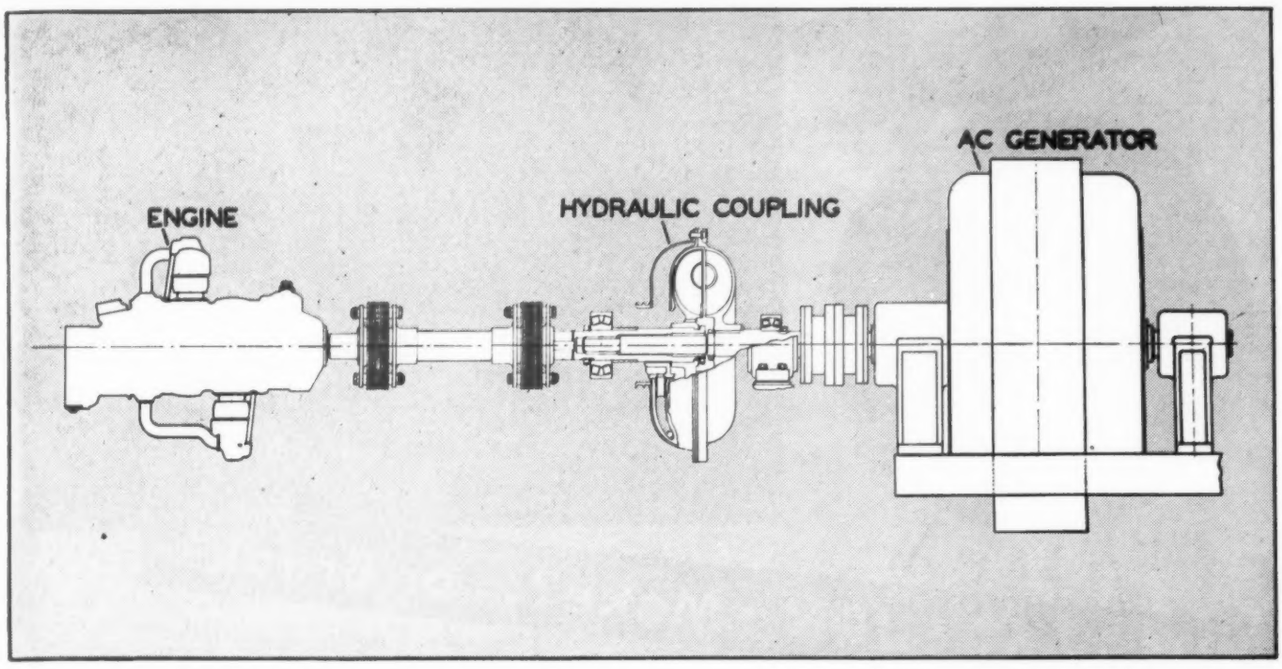


Fig. 2. Schematic view of the regenerative test stand, which enables a drive of varying speed to pump power into a constant-frequency system.

machine and this machine connected to the power system through an adjustable-voltage drive. Well-known principles involving induction machines might be resorted to. A synchronous machine with rotating stator as well as rotor is feasible.

But none of these possible drives will compare favorably, from the standpoint of investment and simplicity, with the drive illustrated in Fig. 2, which drive consists of a conventional synchronous machine tied directly to the power system, together with a slip coupling (a hydraulic coupling in the illustration) interposed between the engine and the synchronous machine.

In the operation of this equipment, the synchronous machine may run as a motor or as a generator. With the coupling de-energized, the synchronous machine is brought to speed and synchronized in the same manner as a conventional synchronous motor. Thereafter, the coupling is energized to make the synchronous machine "turn over" the engine. The engine is fired and after it is warmed up it is brought to a speed above that of the synchronous machine. This machine, then acting as a generator, is loaded back on the power system by slipping of the coupling. The amount of this load is controlled by the engine throttle and the degree to which the coupling is energized.

To illustrate the distribution of engine power, assume that the synchronous machine has a constant speed of 720 rpm. and that the largest engine shown in Fig. 1 is to be tested at speeds of 750 rpm., 900 rpm., and 975 rpm. Then, neglecting machine efficiency, which will not affect the general picture, the power distribution is as follows:

Engine		Coupling Hp. Loss*	Generator Hp. Delivered to Power System
Speed	Hp.		
750	1400	75	1325
900	2500	500	2000
975	3000	780	2220

** Approximately proportional to coupling slip.*

Thus at 3000-hp. output of the engine all of the 3000 hp. is not lost, as was the case with systems of the load-dissipating type. Only 780 hp. is lost. The bulk of the power 2200 hp., is made available for useful purposes by the generator.

Some variations of this fundamental scheme of testing can be employed. For example, it will be noted that the generator will act as a load on the engine only when driven above synchronous speed. If it is desired to load the engine below synchronous speed, this can be done up to the absorption capacity of the coupling by holding the rotor of the synchronous machine stationary—for example, by means of a brake. Fig. 3 illustrates a test run of a typical medium-sized airplane engine under such conditions, using a 900-rpm. generator. At low engine speeds the horsepower delivered by the engine is relatively low so that the coupling will not be called upon to dissipate more horsepower than will be required under maximum running conditions. At low speeds, also, the duration of the test runs is short so that the horsepower-hours lost in the coupling are a relatively low proportion of the total.

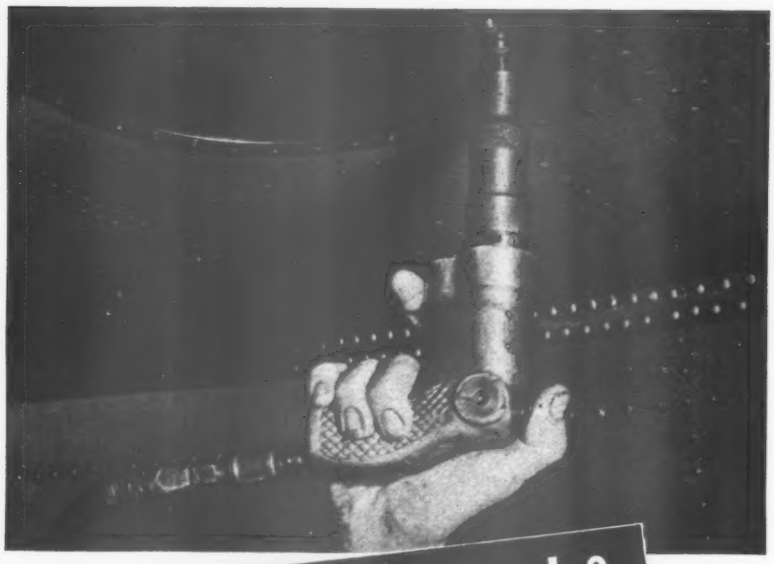
The foregoing application when viewed in the abstract presents several points that are of interest to those who have to do with new and better ways of doing things. In the first place, the fact that this new method of testing was brought into being was the result of an endeavor by a few persons who had the vision and insistence necessary to break away from well-established practice and to delve into the field of improvement.

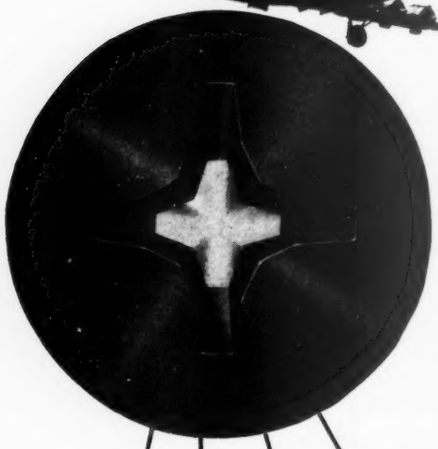
GENERAL CONCLUSIONS

Again, this development is typical of many such developments in that it brought about greater improvement than was originally sought. In this instance, the main objective was economy. This objective was attained but in addition a more effective way of testing large engines was also developed.

Another typical point is that the answer, although relatively simple, as exemplified in Fig. 2, was not at first perceived and was arrived at only by laboriously considering one possible scheme of drive after another. In the scheme shown in Fig. 2, the hydraulic coupling was adopted for the first time in a new role. Previously, it had been used either at low slip values or on drives with rapidly decreasing power with increase in slip, such as fan drives. In the engine-loading application it will be noted that power increases, and increases rapidly, with increase in coupling slip.

Lastly, the application reveals that it is sometimes quite as difficult to dispose of power as it is to generate power.





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Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N.H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N.Y.
Pawtucket Screw Co., Pawtucket, R.I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
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Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
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Strength Analysis of Riveted and Bolted Joints

By WAYNE A. McGOWAN
Senior Stress Analyst, Consolidated Aircraft Corporation

This is Part I of an article describing the method by which the strength of riveted and bolted joints is calculated by the aircraft structural engineer.

RIVETING OR BOLTING is the most commonly used method of assembling the component parts of the airplane. Such joints are designed according to the purpose of the connection and the arrangement of the members which are to be joined. The first requirement to be fulfilled is that such joints be strong enough to transfer safely the forces acting from one part to the other. Some of the secondary factors to be considered and provided for are the appearance of the joint, air and water tightness when required, and the stabilizing effect of the rivets and bolts on the parts which are to be attached. Therefore, a number of joints may be designed for any given case, all strong enough, but varying widely in the size and number of rivets which may be used in any one of them, depending on what secondary requirements are to be fulfilled.

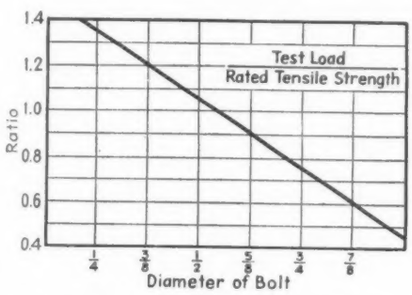

Fig. 1. Chart to find reduction factor in AN castle type steel nuts and steel bolts for sizes larger than ½ in. diameter.

Riveted joints are not well suited for transmitting loads in tension because a slight eccentricity of load exerts a prying action on the rivet head which may result in failure. This tendency is most likely to occur with a condition of repeated loading. Consequently, it is the accepted practice to avoid the use of rivets in tension in any structural part of the airplane. Whenever such loads are unavoidable in non-structural components, a sufficient number and size of rivets should be used so that the resulting stress on any one of them is small. Tensile loads can be properly resisted by bolts and they should therefore be used in any connection subjected to large loads of this nature.

Both rivets and bolts are satisfactory for transmitting shear loads, and the following paragraphs are concerned only with joints which are subjected to forces which produce shear loads on the rivets and bolts.

The strength of a riveted or bolted joint can be determined by reasonably accurate methods of analysis. For explanation, riveted joints only are considered, although the same methods of analysis are also applicable to bolted joints. Such analysis may be used to find the total strength of the joint, though it is more practical in many cases to determine the load on the most highly loaded rivet as the result of a given loading, and then compare this

TABLE II—AN Standard Hex-Head and Clevis Bolts and Pins

Size	*A N part numbers*			*Alum. alloy 24st*			*Steel*	*125000 ult. tension*		
Nominal dia.	*Hex-head Bolt*	*Clevis-head Bolt*	*Clevis pin*	*Shear*	*Tension*		*Shear Bolts and pins*	*Tension*		
								Hex-head bolt		*Clevis bolt*
				Ult.	*Yield*	*Ult.*	*Ult*	*Yield*	*Ult.*	*Ult.*
1/8			AN 392				920			
3/16			AN 393				2070			
10-32	AN 3	AN 23		992	683	1059	2126	1709	2136	1068
1/4-28	AN 4	AN 24	AN 394	1717	1274	1975	3681	3186	3982	1991
5/16-24	AN 5	AN 25	AN 395	2684	2057	3189	5751	5143	6429	3214
3/8-24	AN 6	AN 26	AN 396	3868	3185	4937	8287	7962	9953	4976
7/16-20	AN 7	AN 27	AN 397	5261	4299	6663	11272	10746	13433	6716
1/2-20	AN 8	AN 28	AN 398	6871	5874	9104	14722	14685	18356	9178
9/16-18	AN 9	AN 29	AN 399	8697	7460	11563	18637	18650	23313	11656
5/8-18	AN 10	AN 30	AN 400	10738	9496	14719	23010	23741	29676	14838
3/4-16	AN 12	AN 32	AN 402	15463	13918	21573	33135	34795	43494	21747
7/8-14	AN 14	AN 34	AN 404	21046	19045	29520	45097	47612	59515	29757
1-14	AN 16	AN 36	AN 406	27489	25651	39759	58905	64127	80159	40079

Note: Shear strengths are based on area of shank at full diameter. Tension strengths are based on area of shank at root diameter.

TABLE I—(ANC-5)—Shearing Strength, of Steel Rivets, Bolts, and Pins.

Material		*Low carbon steel*	*Heat treated alloy steel*	*Heat treated alloy steel*
Tensile strength (lb. per sq. in.)		*55,000*	*100,000*	*125,000*
Shear strength (lb. per sq. in.)		*35,000*	*65,000*	*75,000*
Dia. of rivet, bolt or pin (in.)	*Machine screw size*	*Allowable single shear strength (lb.)*		
1/16		107	199	230
3/32		242	449	518
.112	No. 4	345	640	739
1/8"		430	798	920
.138	No. 6	523	972	1122
5/32		671	1247	1438
.164	No. 8	739	1372	1584
3/16		966	1794	2070
.190	No. 10*	992	1842	2126
.216	No. 12	1282	2381	2748
7/32		1315	2442	2818
1/4		1717	3190	3681
5/16		2684	4984	5751
3/8		3868	7183	8287
7/16		5261	9770	11272
1/2		6871	12760	14722
9/16		8697	16152	18637
5/8		10738	19942	23010
3/8		15463	28717	33135
7/8		21046	39085	45097
1		27489	51051	58905

*Note: Bolts listed in the extreme right-hand column, from size No. 10 through 1 in. are AN bolts.

TABLE IIIa.—Allowable Bearing Strength of 24ST Alclad Aluminum Alloy Sheet (Lb.) (Fbr = 82,000 psi).

Dia. of Rivet or Pin (in.)	*1/16*	*3/32*	*1/8*	*5/32*	*3/16*	*1/4*	*5/16*	*3/8*
.014	71	107	143	179	215	287	358	430
.016	82	123	164	204	246	328	410	492
.018	92	138	184	230	276	369	461	553
.020	102	153	205	256	307	410	512	615
.025	128	192	256	320	384	512	640	768
.032	164	245	328	409	492	656	820	984
.036	184	276	369	461	553	738	922	1107
.040	205	307	410	512	615	820	1025	1230
.045	230	345	461	576	691	922	1153	1383
.051	261	391	522	653	784	1045	1306	1568
.064	328	491	656	819	984	1312	1640	1968
.072	369	553	738	922	1107	1476	1845	2214
.081	415	622	830	1037	1245	1660	2075	2490
.091	466	699	932	1165	1399	1865	2331	2798
.102	522	783	1045	1306	1568	2091	2613	3136
.128	656	983	1312	1639	1968	2624	3280	3936
5/32	800	1200	1601	2000	2401	3202	4002	4803
3/16	960	1440	1921	2401	2882	3843	4804	5765
1/4	1281	1920	2562	3202	3843	5125	6406	7687

TABLE III—Shear and Bearing Strengths of Aluminum Alloy Rivets and Sheets

Allowable Single Shear Strength of Aluminum Alloy Rivets (lb.)

Dia. of Rivet or Pin (in.)	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
A17ST (Fsu = 27,000 psi.)	83	186	331	518	745	1325	2071	2984
17ST (Fsu = 30,000 psi.)	92	206	368	573	828	1472	2300	3313
24ST (Fsu = 35,000 psi.)	107	241	429	670	966	1718	2684	3865

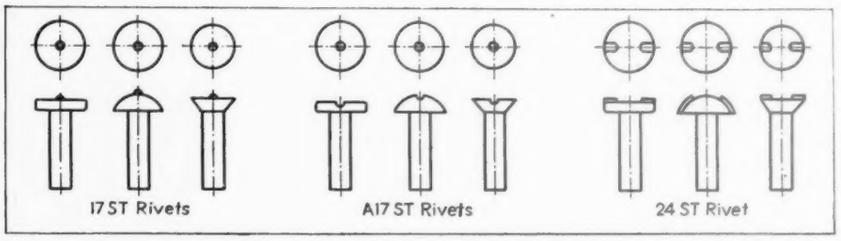

Fig. 3. Rivet head markings used to indicate composition of rivet material.

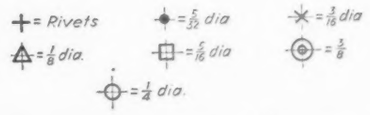

Fig. 4. Symbols denoting diameters of rivet sizes adopted by the Consolidated Aircraft Corp.

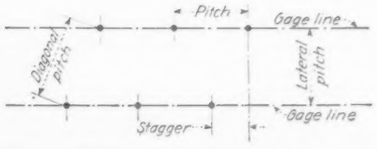

Fig. 7. Diagram illustrating the pitch of rivets used in double rows.

Fig. 2. Characteristic markings placed on the head of each bolt make for easy identification.

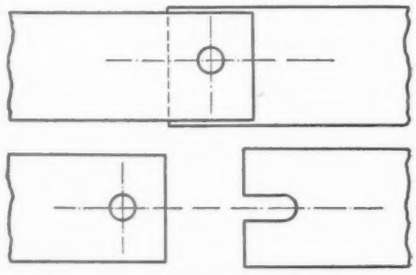

Fig. 5. A lap joint is formed when the plates or sheets to be joined by riveting overlap each other and are fastened by one or more rivets.

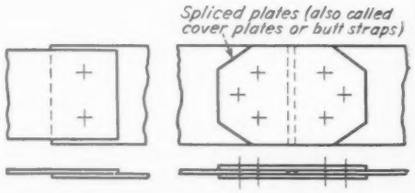

Fig. 6. In a butt joint, splice plates are riveted to the sheets to be spliced which are placed with their edges in the same plane.

computed load with the allowable strength of the rivet. Note that calculated loads and allowable loads are used throughout rather than calculated stresses and allowable stresses. As a result, all mathematical computations are considerably simplified. The allowable loads on all standard rivets and bolts used in aircraft structures can be quickly obtained from tables; for example, Table I and Table III, ANC-5, strength of Aircraft Elements. Portions of these tables are included.

Table I gives the allowable single shear strength of all sizes of steel rivets, steel machine screws, and steel bolts that are commonly used in aircraft construction. An additional Table II has been included to show the shear and tensile strengths of AN standard hex-head and clevis-head bolts made from aluminum alloy as well as steel. The shear strength of AN steel clevis pins is also shown. AN standard parts are those approved by both the Army and the Navy.

AN castle type steel nuts for AN steel bolts (125,000 lb. per sq. in. heat treat) for sizes larger than ½ in. diameter will not develop the full tensile strength of the bolts. The preceding chart, Fig. 1, may be used to find the reduction factor to be used in such cases. To develop the full tensile strength of AN bolts larger than ½ in. diameter it is necessary to use either additional nuts or special nuts with a longer grip. For bolts less than ½ in. diameter the rated strengths given in the table may be used.

The terms machine screws and bolts should not be used interchangeably as they are not identical components. All steel aircraft bolts are made from high tensile strength steel, whereas machine screws in many cases are made from steels which have superior machining properties but lower strength qualities. All bolts listed in the extreme right-hand column of Table I, beginning with size No. 10–32, are AN steel bolts. These can be identified on sight by characteristic markings placed on the head of each bolt as shown by the diagrams in Fig. 2.

Furthermore, all aircraft bolts, with the exception of clevis-head bolts, have six-sided (hexagonal) heads. In one of these two ways, an aircraft bolt can always be recognized from machine screws which are left unmarked. Aluminum alloy bolts of 24ST material are identified by two stampings on the head of each bolt as shown above. Aluminum alloy bolts of 17ST material are inactive for design and procurement.

The use of machine screws is not allowed in the primary structure of the airplane, nor on the attachment of superstructure and accessories where failure would be of serious consequence. Primary structure may be defined as the

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The shear strength of aluminum alloy rivets and the bearing strength of 24ST Alclad aluminum alloy sheet can be obtained by reference to Table III, ANC 5, Strength of Aircraft Elements. The first part of this table, gives the allowable single shear strength of all sizes of rivets that are commonly used in aircraft construction. This portion of the table may be assumed to apply to rivets either with or without countersunk heads.

The Table IIIa, gives the allowable bearing strength of aluminum alloy sheet. The portion of this table applying to 24ST Alclad is shown. These values apply specifically to rivets which do not have countersunk heads. However, they are frequently assumed to apply to rivets with any type of head, although this is unsafe for certain combinations of rivet diameters and sheet thicknesses.

AN standard aluminum and aluminum alloy rivets are made in four forms identified by the numbers AN 425 (78 deg. countersunk head), AN 430 (round head), AN 442 (flat head), and AN 455 (brazier head).

The four AN rivet types are available in four different materials: Type A—Aluminum rivet. No heat treatment, low strength; Type AD—Aluminum alloy (modified 17ST). Furnished heat-treated and driven as received. Moderate strength. F_s = 27,000; Type D—Aluminum alloy (17ST). Heat treatment required before using. F_s = 30,000, and Type DD—Aluminum alloy (24ST). Heat treatment required before using. F_s = 35,000.

The particular aluminum alloy from which a rivet is made is indicated on the rivet by characteristic markings placed on the head of each rivet. The rivet head to which this marking is applied is called the factory or manufactured head. The head formed after the rivet is installed is referred to as the driven or formed head. The rivet head markings used to indicate the composition of the rivet material are shown in Fig. 3. Rivets made from pure aluminum have no characteristic marking on the head.

Rivet sizes may be indicated on a drawing by symbols which denote the diameter as shown by the diagrams in Fig. 4. These particular symbols have been adopted as standard by the Consolidated Aircraft Corporation.

DEFINITIONS AND PRINCIPLES

Riveted joints are divided into two general groups which are classified as *Lap joints* and *Butt joints*. When the plates or sheets to be poined by riveting overlap each other and are held together by one or more rivets, a lap joint is formed. (See Fig. 5.) In a butt joint. Fig. 6, the plates or sheets are placed with the edges to be joined in the same plane, and splice plates are added either on one side or on both sides of the sheets to be joined. The splice plates are riveted to the sheets which are to be spliced, with each rivet extending through the plates and one of the sheets of the joints.

Rivets may be used in one or more rows. Single riveting is one row of rivets in a lap joint or one row on each side of a butt joint. Double riveting means two rows of rivets in a lap joint or two rows on each side of the joint in a butt joint. Rivets are usually spaced at equal distance along these rows, called the gage line. The distance between rivet centers is called the pitch of the rivets. The distance between gage lines is called the transverse spacing on lateral pitch. Diagonal pitch refers to the distance from the center of the rivet in one row to the center of the nearest rivet in an adjacent row when the spacing of the rivets in the rows are staggered. (See Fig. 7).

The simplest form of riveted connection to analyze, is the lap joint in which the two plates overlap each other and are connected together by a single rivet, as in Fig. 8. The plates are assumed to be of equal thickness. It is more convenient to determine the load which the joint can carry than to calculate the stress resulting from a given load.

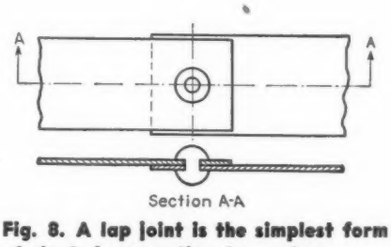

Fig. 8. A lap joint is the simplest form of riveted connection to analyze.

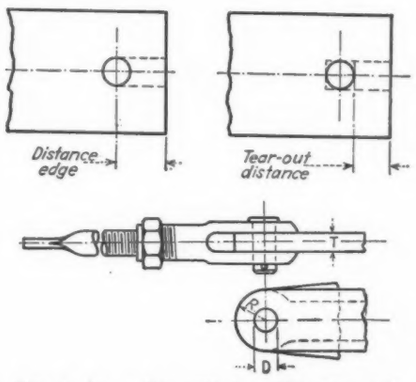

Fig. 9. In a tie rod lug the tear-out strength of a joint varies directly as the thickness of the lug.

Failure of the joint may occur in any one or a combination of two or more of the following ways:

SHEARING OF RIVET SHANK

At the cross-section of the rivet in the plane between the two plates, the load from one sheet is transmitted across to the other by means of shear in the rivet. The resulting stress on the rivet is assumed to be uniformly distributed over the cross-section. For any rivet in shear, the strength of the rivet or the load at which failure will occur is:

Shear Strength of Rivet = $F_s \times A_s \times N$

Where, F_s = ultimate allowable shear stress of the metal from which the rivet is made. (lb./sq. in.)

A_s = cross-sectional area of the shank of the rivet. Most rivets have round shanks for which the area is $A_s = \pi r^2 = \pi \left(\frac{D}{2}\right)^2 = \pi \frac{D^2}{4} = .7854\ D^2$

It is important from a design viewpoint to observe that the shear area and consequently the shear strength of a rivet varies as the square of its diameter. Thus, doubling the diameter of the rivet shank multiplies its strength by four.

N = Number of planes along which the rivet tends to shear. Rivets having one such plane are said to be in single shear. Two such planes are referred to as double shear, etc. For design purposes, the load required to shear a rivet may be assumed to increase directly as the number of planes upon which shear occurs, so that in double shear a rivet is twice as strong as in single shear. The allowable ultimate load in single shear for all sizes of aluminum alloy rivets that are commonly used in aircraft construction are tabulated in bulletin ANC-5, Strength of Aircraft Elements, from which Table III was taken. Consequently the shear strength of these rivets can be obtained without computation.

SHEARING OF THE SHEET

The strength of the sheet in this respect is sometimes assumed to be the shear strength of the two areas between the center line of the rivet hole and the edge of the sheet. This distance, from the *Centerline* of the rivet hole to the edge of the sheet, is termed the *edge distance*. (See center diagram).

The shear strength of the sheet obtained by using the edge distance dimension is not conservative. The failure of the sheet will be along the line of minimum area which would be somewhat less than the distance to the center-

line of the rivet. Furthermore, the failure of the sheet will most likely be a combination of shear along one of the faces after which the sheet in way of the rivet is bent so that the rivet is allowed to pass.

A more reasonable value for the strength of the sheet in shear is obtained by assuming that the sheet shears along two areas between the *edge* of the rivet hole and the edge of the sheet. This distance, from the edge of the rivet hole to the edge of the sheet, is termed the *tear-out distance* (abbreviated T. O.). The use of the tear-out distance is equivalent to the assumption that the rivet is square and has the same dimension for any side as the diameter of the actual rivet.

The shear strength of the sheet, or the load at which failure will occur is:

Tear-out strength of sheet = $F_s \times A_s$

Where F_s = ultimate allowable shear stress of the metal from which the sheet is made (lb./sq. in.)

A_s = Cross-sectional area of the sheet along which the sheet tends to shear = 2 × tear-out distance × thickness of sheet.

t = Thickness of sheet.

There are two areas along which the sheet tends to shear. The equation for tear-out strength is therefore

Tear-out strength of sheet =

$$2 \times F_s \times T.O. \times t$$

An equation equivalent to this but differently expressed is given in bulletin ANC-5 for determining the allowable shearing strength in the eye of a tie rod, Fig. 9, or lug:

$$P_s = (2R - D)tF_s$$

where

P_s = Allowable shearing strength in the eye or lug in lb.

R = Outside radius of eye.

D = Diameter of pin.

t = Thickness of lug.

F_s = Ultimate allowable shear stress of the metal from which the lug is made (lb./sq.in.)

It should be observed from the two formulas given above that the tear-out strength of a joint varies directly as the thickness of the sheet, or lug; thus, if the thickness is large, the theoretically required tear-out distance is very small. Such small tear-out distances may not be sufficient to prevent bulging of the sheet when the rivet is driven, thus causing a weakened and unsightly joint. In such cases, the rivet must be either under-driven or a bolt substituted for the rivet. In some cases it is possible to pack up the edge of the sheet during the driving process. Beneficial results can also be obtained by inserting the preformed head on the side of the joint having the smaller tear-out distance.

Experience has shown that if an edge-distance measured in terms of the diameter of the rivet of from one and one-half to two diameters is maintained between the centerline of the rivet and the edge of the sheet, the joint will not fail by tearing out. For this reason it is not necessary to calculate the tear-out strength of joints which satisfy this edge distance requirement. However, all joints which do not appear to have sufficient edge distance should be checked for strength. For design purposes a curve of the strength of all standard gages of 24ST Alclad sheet for any given tear-out distance has been constructed and included so as to be immediately available. (See Fig. 10.)

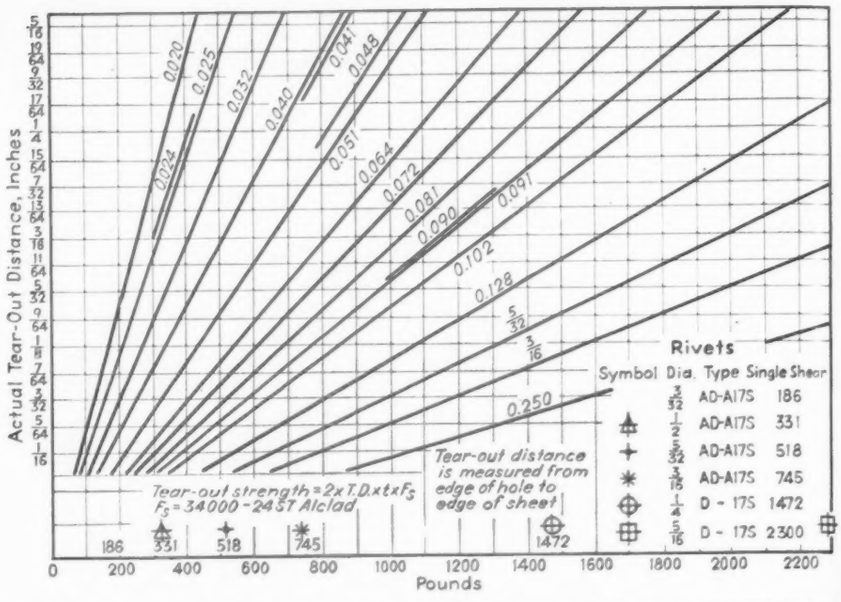

Fig. 10. Curve depicting the tear-out strength of all standard gages of 24ST Alclad sheet.

CRUSHING OF SHEET BEARING ON RIVET

At one side of the rivet hole in one sheet and on the opposite side of the rivet hole in the other sheet, the load is transmitted between the sheet and the rivet in compression, or as more commonly stated, in bearing.

On account of the cylindrical surface of the rivet and the rivet hole, the resulting stress is variable in both direction and intensity. However, for the purpose of determining the strength of the joint, the bearing stress is assumed to be uniform. As a result, the bearing strength of the sheet, or the load at which failure will occur, is:

Bearing strength of sheet = $F_{br} \times A_{br}$

Where

F_{br} = Ultimate allowable bearing stress of the metal from which the sheet is made. (lb./sq.in.)

A_{br} = Projected area of the rivet hole against which the rivet bears = Diameter × thickness.

Bearing strength of sheet = $F_{br} \times D \times t$

The allowable ultimate load in bearing of 24ST Alclad sheet of different gages when used in conjunction with the various sizes of rivets that are commonly used in aircraft construction are tabulated in Bulletin ANC-5, from which Table IIIa was taken. Consequently, the bearing strength of any rivet installed in 24ST Alclad sheet can be obtained without computation.

An examination of the equation for determining the crushing strength of the sheet bearing on the rivet shows that the strength in this respect is theoretically independent of the tear-out or edge distance. Actual tests have shown, however, that the ultimate bearing strength of most metals is reduced if the edge distance in the direction of loading is not equal to at least twice the diameter of the rivet.

For smaller edge distances, the bearing strength drops off about in proportion to the decrease in edge distance, so that for an edge distance of one and one-half diameters the bearing strength is only about three-fourths of that obtained for an edge distance of two diameters. This variation of bearing strength is only approximate, and since the tear-out strength is more directly related to the tear-out dimension, this later criterion is used by designers to insure that the tear-out distance is sufficient for any given loading.

If the rivet and sheet are of different materials having different allowable bearing stresses, it is necessary that the lower of the allowable stresses be used in determining the bearing strength of the joint. Bearing failures, in the form of crushing or excessive compressive

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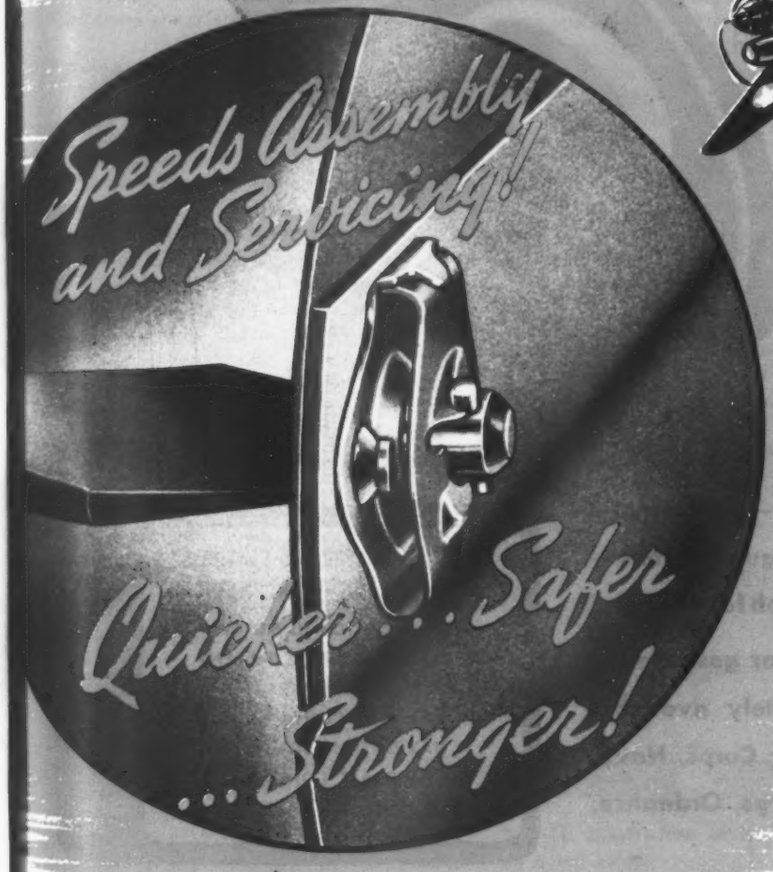

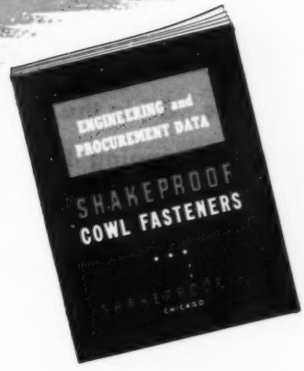

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distortion of the metal, are not easily recognized in the rivets themselves. Tests have shown, however, that if a soft rivet such as made from aluminum alloy is used in a hard sheet such as steel and if the plate is thin enough so that the intensity of the bearing stress exceeds about three times the shear stress, the rivet will fail in shear at a shear stress lower than its normal shear strength determined in tests with thicker sheets.

When bolts are used in a joint the threaded portion of the bolt shank should not be used as a bearing surface. The use of threads in bearing is not allowed in any of the components included in the primary structure. In less important installations where a slight yielding of the joint is permissible, the threaded portion may be used, but the allowable bearing load assumed for such a joint should not exceed 25 percent of the rated shear strength of the bolt.

TENSILE FAILURE OF SHEET THROUGH THE NET SECTION

The strength of the sheet through the cross-section at which the rivet hole occurs is less than the strength of the cross-section of the sheet at any other point where the cross-sectional area has not been decreased by rivet holes. The cross-sectional area of the reduced section is called the net cross-sectional area to differentiate it from the gross cross-sectional area which is unaffected by rivet holes. The tensile strength of the sheet, or the load at which failure will occur is:

Net tensile strength $= F_t \times A_t$

Where,

F_t = ultimate allowable tensile stress of the metal from which the sheet is made. (lb./sq.in.)

A_t = Net cross-sectional area of the sheet measured in a plane which is normal to the direction of the load.

For a width (W) of sheet which has but one rivet hole of diameter (D), the net cross-sectional area is t(W-D). The net area with any other number of rivets can be computed by the same expression by substituting the appropriate number of D's, or t(W-nD).

Net tensile strength of sheet$=F_t t$ (W—nD).

The ratio of the net cross-sectional area to the gross cross-sectional area is sometimes used in the calculation of the allowable tensile load on a riveted joint and in other computations as well. This ratio, called the rivet factor, is most easily computed as follows:

$$\text{Rivet factor} = \frac{W - nD}{W}$$

Where only a width of sheet equal to the pitch distance is being considered, the rivet factor is:

$$\text{Rivet factor} = \frac{P - D}{P}$$

The action when a rivet joint fails is actually more complicated than the simple elements listed above. It has been found that the intensity of the stresses at the edges of the hole is considerably higher than the average. There are also some bending and tensile forces exerted upon the rivet in addition to the bearing and shearing forces. If the resultant of the pressure from each plate is assumed to act midway between the surfaces of the plate, the moment upon the rivet is $P(.5_{t_1}—.5_{t_2})$, which, for plates of equal thickness, becomes $p \times t$.

This moment must be balanced by an equal and opposite moment consisting of bearing forces F-F (see diagram, Fig. 11) exerted by the plate upon the head of the rivet thus causing tension in the rivet head. In addition, there is a bending of the plate in the case of lap joints since the two forces P—P are not in the same plane, and the plates, if not too thick, rotate in the region until this condition is partially fulfilled. The frictional force developed between the plates add somewhat to the strength of the joint, but is of such small and uncertain magnitude that it is always neglected.

Most joints consist of several rivets instead of a single rivet as in the previous example. To determine the strength of such joints it is necessary to take into account the position of the line of action of the resultant of the applied load. If the resultant of the load passes through the center of resistance of the rivet group it can be assumed that all of the rivets are equally stressed if they are made of the same material. Consequently, it can be assumed that each of the rivets, if they are of the same size, will carry equal loads. Exceptions to this condition will be considered later. The present example involves a centrally loaded rivet group, Fig. 12, used to attach the cover plates on a butt joint. Allowable shear loads on the rivets and allowable bearing loads for the 24ST Alclad plates forming the joint are obtained from Table III.

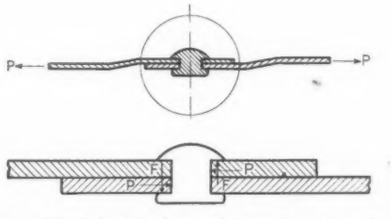

Fig. 11. Illustration of bearing forces on a lap joint.

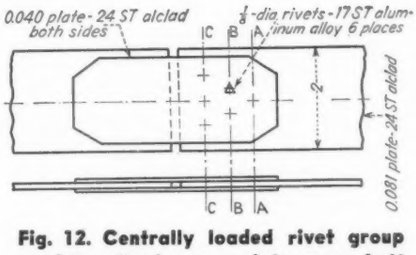

Fig. 12. Centrally loaded rivet group used to attach cover plates on a butt joint.

The allowable load which can be transferred by the six-$\frac{1}{8}$ rivets acting in double shear is:

$P_s = 6 \times 2 \times 368 = 4416$ lb.

The allowable load on the .081 Alclad plate in which the six-$\frac{1}{8}$ rivets are installed is

$P_{br} = 6 \times 830 = 4980$ lb.

The allowable load on the two .040 Alclad cover plate in which the six-$\frac{1}{8}$ rivets are installed is

$P_{br} = 6 \times 2 \times 410 = 4920$ lb.

The allowable load which can be transferred by the .081 plate across the net cross-section at A-A is determined as follows

$F_t = 56{,}000$ lb./sq.in. ANC-5

$T_{AA} = .081\ (2—.125)\ 56{,}000 = 8505$ lb.

The allowable load which can be transferred by the .081 plate across the net cross-section at B-B is

$T_{BB} = .081\ (2—.250)\ 56{,}000 = 7938$ lb.

And the allowable load which can be transferred by the .081 plate across the net cross-section at C-C is

$T_{CC} = .081\ (2—.375)\ 56{,}000 = 7371$ lb.

An inspection of the values obtained for the strength of the .081 plate at the various sections shows that the allowable load on section C-C is less than for the other sections. This is true since the greatest number of rivets in any row occur at this section, thus reducing the total cross-sectional area to a minimum.

However, the most highly stressed section is not necessarily at section C-C. At section A-A the entire load applied to the joint must be transferred across the net cross-section. Thus, the entire load on the joint is the same as the allowable load on this particular cross-section.

The one rivet in row A-A transfers one-sixth of the load into the cover plates thus leaving five-sixths of the loads to be transferred across the next cross-section which is at B-B. Since only five-sixths of the total load applied at the joint is transferred to section B-B, the allowable load on section B-B of 7938 lb. corresponds to a total load on the joint of $6/5 \times 7938$ or 9525 lb. This load is greater than the total joint load previously determined. Consequently, section B-B is not the critical section.

In a similar way, the load required to be transferred across section C-C is only one-half of the total load applied to the joint. The allowable load on section C-C of 7371 lb. therefore, corresponds to a total load on the joint of

(*Turn to page 206*)

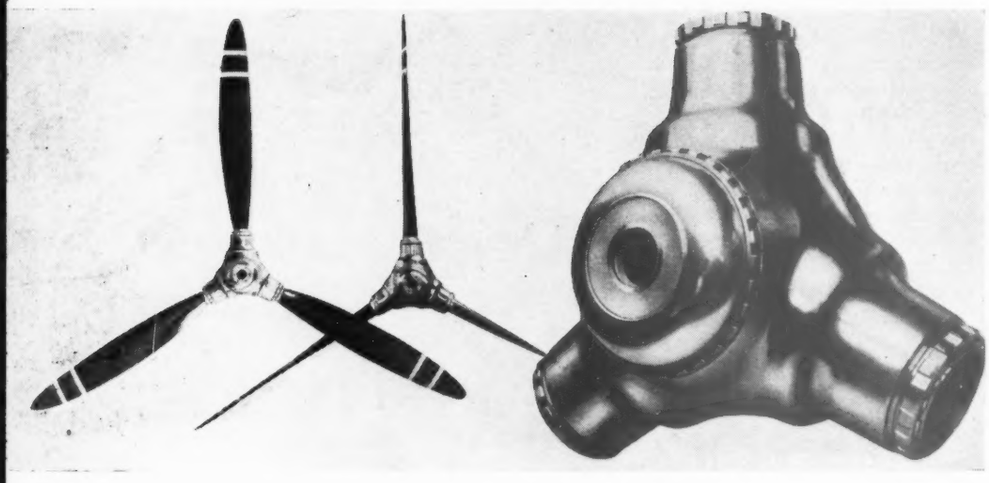

FIG 1

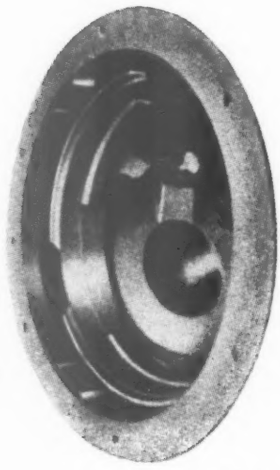

FIG 2

Escher Wyss Variable Pitch Propeller

By DR. C. KELLER, *Escher Wyss Engineering Works Ltd., Zurich, Switzerland*

THE ADVANTAGES OFFERED by the variable-pitch propeller are not nearly utilized to their fullest extent in military and civil aeronautics at the present time. It is quite true that current types make possible a more or less satisfactory adaption—dependent on construction and operating principles—of the propeller to the wide speed and performance ranges of modern airplanes under take-off, cruising and maximum speed conditions. For these purposes between 15 and 30 degrees of pitch angle change are adequate. However, future developments will go far beyond these requirements.

By setting the blades at high pitch, for example, extraordinarily high flying speeds can be reached in accelerated glide descents without risking engine racing.

The feathering of the blades enables the rotation of the engine to be stopped in the event of engine failure, concurrently with the reduction of propeller drag to a minimum, a maneuver that has been found to be of partcular value in the case of damage to the power plant of multi-engined airplanes.

By setting the blades at negative pitch angles, on the other hand, the propeller assumes the functions of an efficient air brake in dives and during the landing run without necessitating the additional weight of special brakes. Dives can thus be carried out at much reduced velocities which is important especially for military purposes. The normal landing run may be reduced by as much as two-thirds in some cases, a feature that is highly desirable when fairly small airfields are utilized.

Furthermore, the favourable effect of constant-speed operation on the different flight maneuvers, resulting from the maintenance under all conditions of constant propeller engine rpm. should be noted.[1]

However, for the materialization of these demands, the creation of a new and harmonized design of propeller hub was found necessary as well as of the control and operating mechanisms. Such a type, developed systematically and capable not only of meeting the present but no doubt also the future requirements mentioned above, is in production at the Escher Wyss works. Development work on the propeller was much facilitated by studies and suggestions made by the Institute of Dynamics of the Swiss Federal School of Technology (Prof. Dr. J. Ackeret) and by the Technical Section of the Federal Military Department.

The firm of Escher Wyss is probably the only undertaking to have gained extensive engineering experience in the entire field of high-speed rotating machines (steam and water turbines, axial and radial compressors, blowers and pumps as well as variable-pitch marine propellers). The high speeds of modern machines of these types led to the adoption already years ago of blade designs resembling airfoil sections and—in order to obtain the highest degree of efficiency under different operating conditions—of blades controllable, mostly automatically, in actual operation.

The company's long activity in the development of such machines and the application of the experience gained in one specialized field to another offered a solid basis for the creation of a hub suitable for operation under the stress

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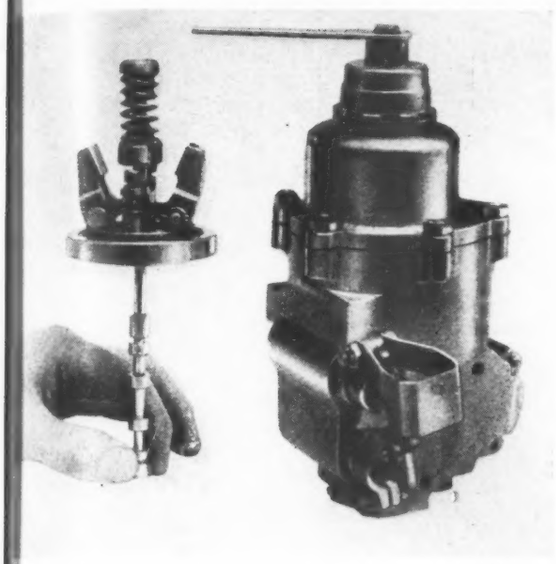

FIG 3

Fig. 3. Combined governor and pump unit incorporates auxiliary pump for extreme pitch setting as well as constant speed apparatus and switching devices.

Fig. 4. The adjusting cylinder with three lugs for the connecting links encompasses an automatic device for locking the blades in any momentary position.

Fig. 5. A soap skin model provided the basis for the design of the Escher Wyss hub.

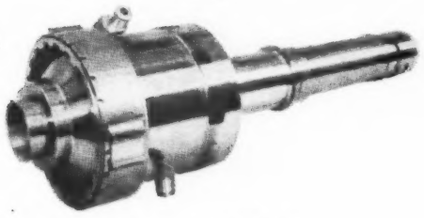

FIG 4

FIG 5

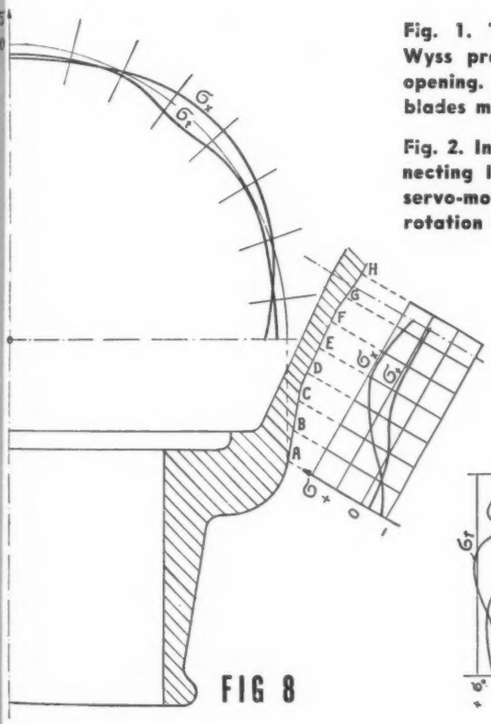

FIG 8

Fig. 1. The short, single-piece Escher Wyss propeller hub with central firing opening. With full range of adjustment, blades may be locked in any position.

Fig. 2. Inside the hub, the play-less connecting link transmission translates the servo-motor motion directly into blade rotation without making use of gears.

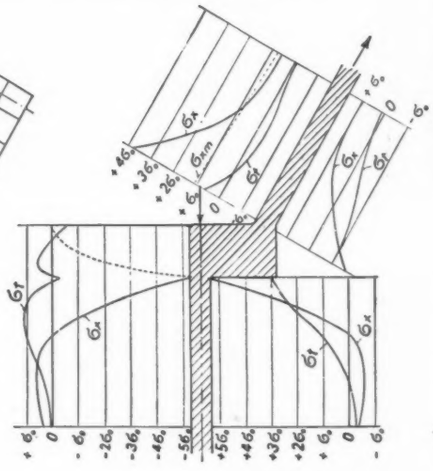

FIG 9

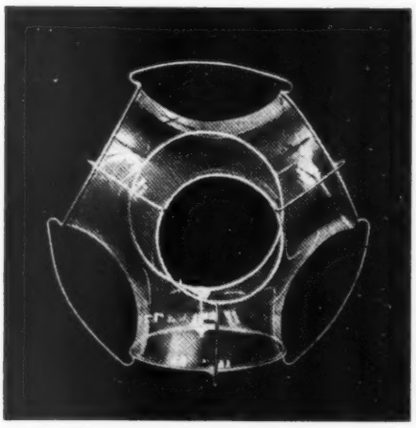

FIG 6

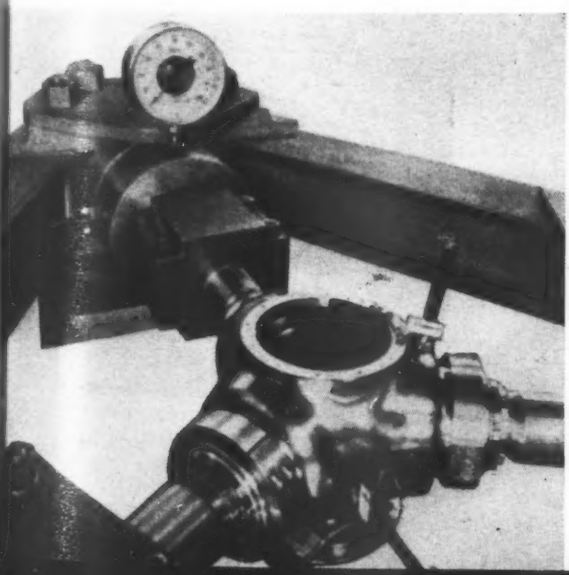

FIG 7

Fig. 6. From the soap skin model a hub was constructed in which a body of uniform strength was ensured.

Fig. 7. Tensometer by which the course of hub stresses is determined.

Fig. 8. Graphic representation of hub stresses as determined by tensometer measurements.

Fig. 9. Diagrammatic solution of stresses based on tensometer measurements.

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Synthetic Resins In Construction

By H. N. HAUT, *Bellanca Aircraft Corp.*

PART II . . . In part I, appearing in the March, 1942, issue of AVIATION, the author described the background of modern wood construction. Now, in the following article, some interesting and useful test results of synthetic resin bonding in wood construction are discussed.

THE history of airplane construction will show a decline in the use of wood and wood products coincident with the development of light metal alloys, and a decided up-turn in synchronizing with the appearance of resin bonded plywood, a very natural evolution when we consider the factors involved.

Before the advent of resin bonding, plywood had not been a favored material with aircraft designers, principally because of its indeterminate strength, which with the animal adhesives, varied with the vagaries of the weather, so to speak, and delaminated in the humidities of our own temperate climate. The introduction of casein glue and its subsequent improvements added to the reliability and water resistance, but not sufficiently to merit the structural confidence of engineers, especially where tropical exposures were to be considered. Moreover, casein glued joints of the day generally had to be reinforced with nails and profusely protected by surface coatings.

The resin bond in plywood which definitely fixed its reliability reawakened the interest of the wood-minded engineers, with the subsequent and ever increasing appearance of plywood structures. The long time exposure tests by Brouse[7] covering a period of four years at our Forest Products Laboratories went far to establish the durability, water resistance and resistance of parasitic growths, of the phenolic bond.

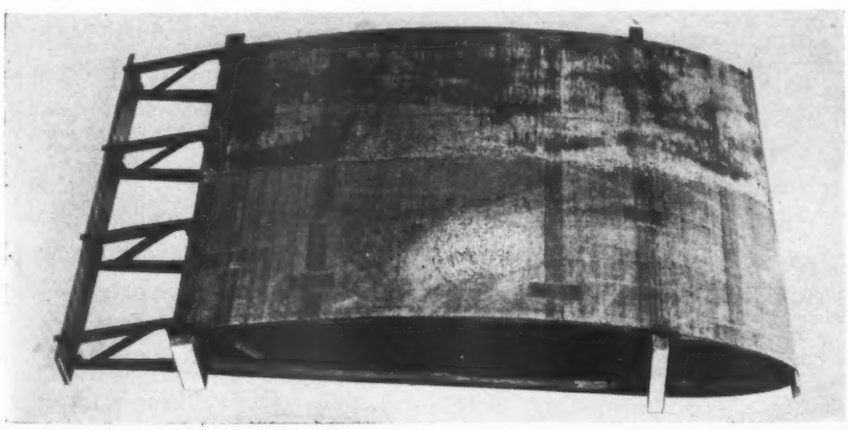
ADVANTAGES OF PLYWOOD

The desirability of using plywood in place of metal in certain applications is still best illustrated by examining a typical stressed skin wing or a typical monocoque fuselage, of metal. It is seen that even the most ingenious design cannot avail itself of the full compressive strength of the metal, which fails by local buckling before the ultimate metal strength is reached. We, therefore, find a variety of stiffeners, in the form of angles, channels and corrugations, used to support the unstable skin. They must also be rigidly attached to the skin with closely spaced rivets and with a corresponding increase in the drag of the surface.

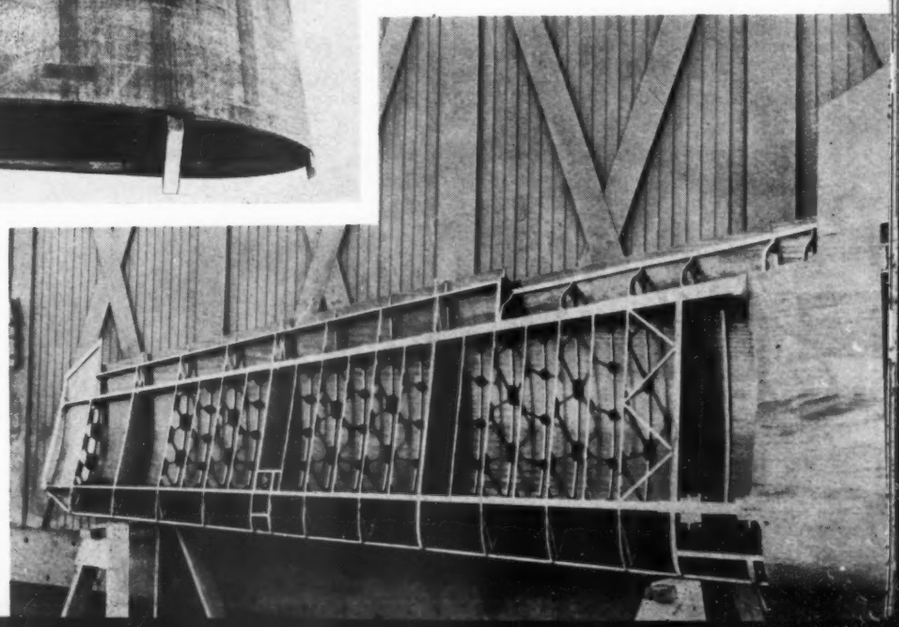
Now Clark[6] has shown that for a given weight a thicker shell of lower density material without stiffeners will support a greater stress than a metal shell with stiffeners and upon this thesis is founded one of the plastic airplanes of today. Add to these findings the basic synthetic resin research results, a continued improvement in the technique of forming, compound curves of plastics reinforced wood and a utilization of the plastic properties of the plastics, that is, its susceptibility to forming and to remain formed (I refer now to the irreversible thermosetting resins) and we have, by a natural succession of events, arrived at the plastic airplane.

PLASTIC CONSTRUCTION

There has appeared in the literature, descriptions of three plastic airplanes. Essentially all three are based on plastics bonded or plastics reinforced wood. True to tradition, one is reported to use a thermoplastic resin of the butecite type, and one a phenolic resin and the third a urea formaldehyde resin.



Test panel bonded with low temperature phenolic resin after successfully withstanding exposure in the open for over a year.



Model 14-9 Bellanca Cruisair wing panel bonded with low temperature phenolic resin.

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Briefly, the one using the butecite resin is constructed by impregnating or soaking thin veneers and by tightly winding them around mandrels or forms, the number of layers determining the strength of that portion of the structure. The mandrels and forms are then assembled and bound together by additional veneers so as to form the skin and bind it to the component parts, in such a way as to make the mandrels removable after the heat-treatment.

Upon completion, the entire assembly is encased in a rubber bag from which the air is exhausted and is then placed in an autoclave and exposed to about 80 or 90 lb. of steam pressure until the impregnated veneers are fused together. The mandrels and the outer surface of the structure must necessarily be treated to prevent the adhesion of the resin.

The second is reportedly constructed by laying carefully fitted veneers, prepared with a liquid phenolic resin, on a male form and by subjecting them to mechanical pressure and simultaneous heat, while the third is prepared on a male form with a liquid urea resin and is then encased in the rubber bag followed by the autoclave treatment.

The exact processes and methods of control of impregnation, pressures and densities are rather closely guarded manufacturers' secrets.

At this writing, none of the above airplanes have appeared on a production scale, and it is assumed that the usual problems of production, designs, and perhaps costs need to be overcome first.

The conception of plastics and the uses of plastics in airplane structures do not entirely revolve around the moulded structures. There is another, more conservative school of thought which bases its design on the utilization of natural wood where efficiency of design, ease of manufacture and sustained supply are controlling factors. This school also advocates the use of prefabricated resin bonded and resin reinforced products, plywood, of course, being the most common.

The use of wood and glue in aircraft manufacture is as old as the industry itself.

As a structural material its value is undisputed. High strength, weight ratio, high resilience, corrosion resistance, ease and rapidity of fabrication on high speed machinery and the like, are all characteristics associated with wood.

JOINT EFFICIENCY HIGH

In the important matter of joint efficiency, wood again claims an advantage over the other materials. The most perfect weld in a steel structure anneals and reduces the strength of the base metal adjacent to the weld. The rivet demands the sacrifice of rivet holes. Even the spot weld converts its area of wrought base metal to a casting with consequent reduction in strength. The glued joint does not require such sacrifices.

This optimistic picture, however, is not without its blemishes, since it must be recognized that the many advantages of wood have been offset to a great extent by the lack of permanent dependable joints in component parts. The great

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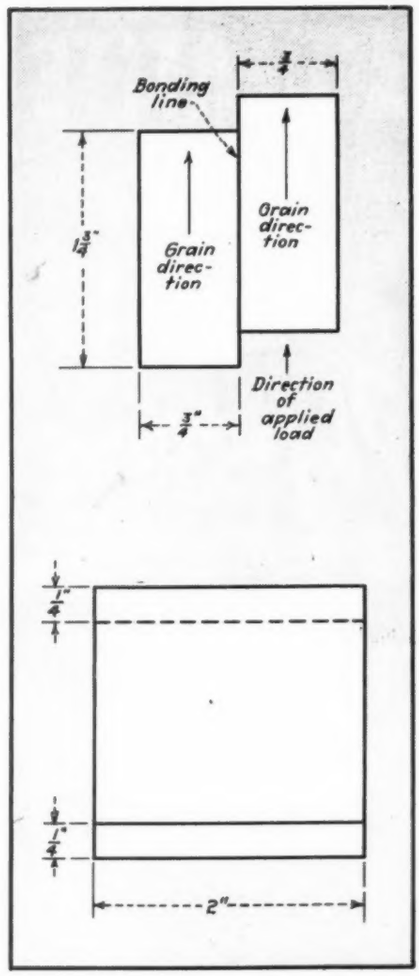

Fig. 1. Typical bonding shear test specimen.

Fig. 2. Results of comparative shear tests on resin plastics and case in glue bondings.

1. Plastics bonds heat-treated four (4) hours at 140° F. (60° C.)...2. Casein joints in clamps overnight at room temperature 86° F. (30° C.) then aged 10 days... 3. Each value listed below represents the average of from 3 to 10 individual tests.

Physical Data

	* Moisture Content	* Specific Gravity
Spruce	11.5%	.40
Birch	12.0%	.687
Maple	15.0%	.68
Bass	12.4%	.456

* Based on oven dry weight.

Materials	Relative Grain Direction	Direction of applied Load	Area	Percent Wood Failure	Lb. per Square Inch
PLASTICS FORMULA 944-6					
Spruce & Spruce	Parallel	Parallel	3 sq. in.	100	1218
" "	"	to	ditto	100	1400
" "	"	Spruce	"	100	1131
" "	"	Grain	"	100	1400
" "	"		"	100	1218
CASEIN GLUE					
" "	"	Parallel	"	100	1350
" "	"	to	"	100	1400
" "	"	Spruce	"	100	1131
" "	"	Grain	"	100	1218
" "	"		"	100	1430
PLASTICS FORMULA 945-6					
Birch & Birch	Parallel	Parallel	3 sq. in.	80	2680
" "	"	to	ditto	100	2900
" "	"	Birch	"	80	2730
" "	"	Grain	"	80	2680
" "	"		"	100	2900
Birch & Birch	Parallel	Parallel	3 sq. in.	20	1530
" "	"	to	ditto	5	2010
" "	"	Birch	"	25	2100
" "	"	Grain	"	5	1675
" "	"		"	10	1348
PLASTICS FORMULA 945-6					
Birch & Maple	Perpendicular	Parallel	"	100	1115
" "	"	to	"	95	1131
" "	"	Maple	"	85	1115
" "	"	Grain	"	80	1032
" "	"		"	90	1115
CASEIN GLUE					
" "	"	Parallel	"	0	527
" "	"	to	"	0	652
" "	"	Maple	"	0	560
" "	"	Grain	"	0	620
" "	"		"	0	495
PLASTICS FORMULA 945-6					
Birch & Birch	Perpendicular		"	90	1032
" "	"		"	90	1000
" "	"		"	100	1115
" "	"		"	100	1115
" "	"		"	85	1032
CASEIN GLUE					
" "	"		"	5	652
" "	"		"	5	620
" "	"		"	0	527
" "	"		"	10	835
" "	"		"	5	652

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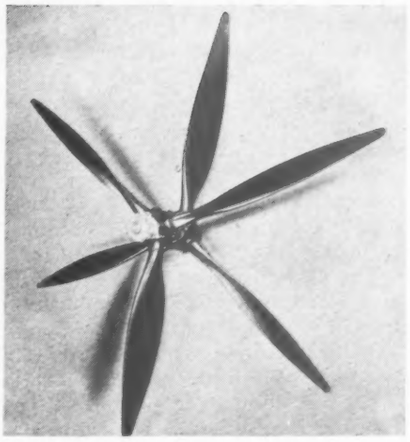
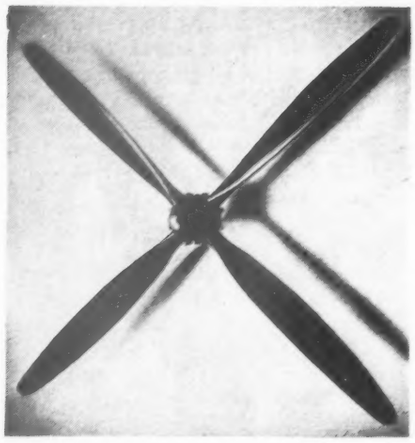


A 6-blade contra-rotating propeller made by de Havilland.



De Havilland 4-blade propeller for 2,000 hp. engines.

De Havilland Developments

The first details on two new developments in all metal propellers made by the de Havilland Aircraft Co., Ltd., have reached us from England. One is a 4-blader for use on engines of 2,000 hp., and over such as are installed on the Avro Manchester, one of the RAF's heavy bomber types. The other is the de Havilland counter-rotating propeller. Both are constant-speed, full-feathering types.

With the advance in higher powered supercharged engines for operation at great altitudes, three blades cannot provide enough "bite" to work effectively in the rarer atmospheres, unless the propeller has so large a diameter it cannot be accommodated by normal landing gear.

An important feature is the use of metal blades. Not only does metal make possible the thin blade sections necessary for obtaining the last ounce of efficiency, and the relatively small blade roots which permit use of a correspondingly small hub with reduced weight and cleaner spinner profiling, but also increased serviceability and conservation. It has been found that in forced landings with landing gear retracted, such as sometimes occur in active service, the strong malleable duralumin blades can be relied upon to bend backward and form skis, protecting the main body of the engine and the whole airframe, thus localizing the damage. As for the blades themselves, 80 percent of those which are damaged in crashes or gunfire (including those "holed" by bullets) are salvageable and go back into service.

In the de Havilland 4-blade series the maximum diameter is 16 ft. Other sizes are being built to cover the range of operational horsepowers. The 6-blade contra-rotating propeller is one of the latest developments from the de Havilland factories and represents the most important technical advance since the firm produced their first controllable pitch propeller in England on July 30, 1935. The purposes of the contra-prop have been made familiar in recent discussions in the technical press (see AVIATION, Oct., 1941, p. 127). An important advantage is that the counter rotation straightens out the slipstream, eliminating swing at take-off.

In the de Havilland 6-blader, fundamental design features of the earlier Hamilton and de Havilland propellers are retained, notably the light alloy forged blade with upended root, the blade anchorage, and the transmission of torque and centrifugal loads through spider and barrel structures. The resultant compactness of the hub assembly is notable. No details of sizes and horsepower capacities are available at present.

Blanket Protection From Shrapnel

A protective blanket of animal hair mat, about one-half inch thick, glued directly to a factory window, has been found to offer almost perfect protection against flying glass, shrapnel and bomb splinters, according to tests conducted by the U. S. Army at Patterson Field, Ohio.

Invented by H. G. Mathews of Brown & Mathews, Inc., 122 West 42nd St., New York, N. Y., builders of the Edo Aircraft plant on Long Island, the protective device is backed by wire mesh. The glass with this combination was smashed with a sledge hammer bullets were fired through it, and finally the Army tested it with 8 lb. of T.N.T. Every test is said to show the same result. The glass broke, but it did not spread, scatter or pierce the protective mat. The explosives dented the sash but no shrapnel or other missiles penetrated. The conclusion reached by rank-

Convoy of Commerce

Off shore... above coastal sea lanes... among islands... Lockheed Hudson bombers fly guard over ships that carry men and supplies to all our fighting fronts.

These vigilant sentinels are heirs of the first Lockheed Hudson—first American ship to serve with Britain's Coastal Command. In structure, they are the same tough transport design that needed few changes to become a famous bomber.

In armament, they are superior... re-armed and turreted to take full advantage of the lessons of total war.

In tradition of performance, they live up to the reputation of the Hudsons that helped perform the miracle of Dunkerque ...smashing hard, smashing often, to crush our Axis foes.

... for Protection today and Progress tomorrow

LOOK TO *Lockheed* FOR LEADERSHIP

Hudson Reconnaissance Bomber • Lockheed Aircraft Corporation • Burbank, California

ATTACK!

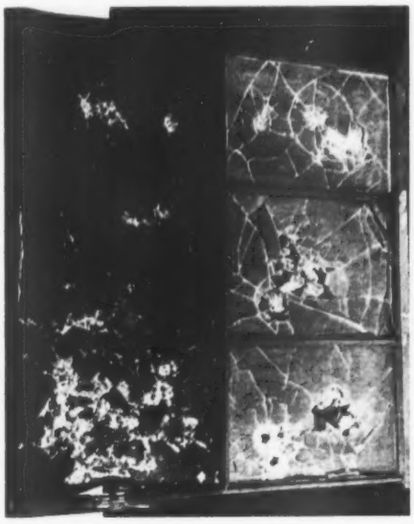
An important factor in any action against the enemy is freedom from interference in communication. Breeze Radio and Ignition Shielding makes possible undistorted reception and transmission of messages from aircraft to ground under all operating conditions. An early Breeze development, this ignition and secondary system shielding is used today on all types of American military and naval aircraft — is daily playing a vital role in helping America gain supremacy of the skies.

With all its plants in full production for the needs of national defense, Breeze is turning out in quantity the equipment which will give America victory in the air, on land and on the sea.

Breeze BREEZE MARK CORPORATIONS INC.
NEWARK, NEW JERSEY

ing Army officers, industrial executives and others present, it is reported, was that a factory so protected would be safe from anything save a direct hit from a bomb.

Further virtues reported of the protective blanket are found in the fact that it can be applied to each sash separately



Window sash fitted with protective mat showing results of T.N.T. and gunfire tests.

so that normal ventilation is possible; mustard and other poison gases do not penetrate, and it is easily removable when no longer needed.

Patents Review

The following recent patents on aviation developments have been announced by the U. S. Patent Office:

Aircraft Control. No. 2,274,571. Walter Wisk, New Britain, Conn.—A control mechanism for aircraft, having a fuselage and at least two wings pivoted thereto, comprising a pair of spaced operating members respectively connected to said wings. Each of these members is movable in one direction for imparting movement to the wings and with other devices that when so moved other member moves in other direction, together with other various movements.

Aircraft Wing Structure. No. 2,273,919. George A. Allward, Hagerstown, Md., assignor to John F. Neary, Jr., trustee.—A structure for aircraft wings and the like, comprising a hollow shell of airfoil contour consisting of upper and lower half shells. These are connected, each comprising a plurality of layers of plywood bonded to each other, and are of progressively decreasing lengths longitudinally of the wing so as to progressively overlap from the butt toward the tip of the wing. Each layer extends chordwise of the wing from the leading edge thereof to provide a shell wall of substantially uniform thickness at any transverse section therethrough.

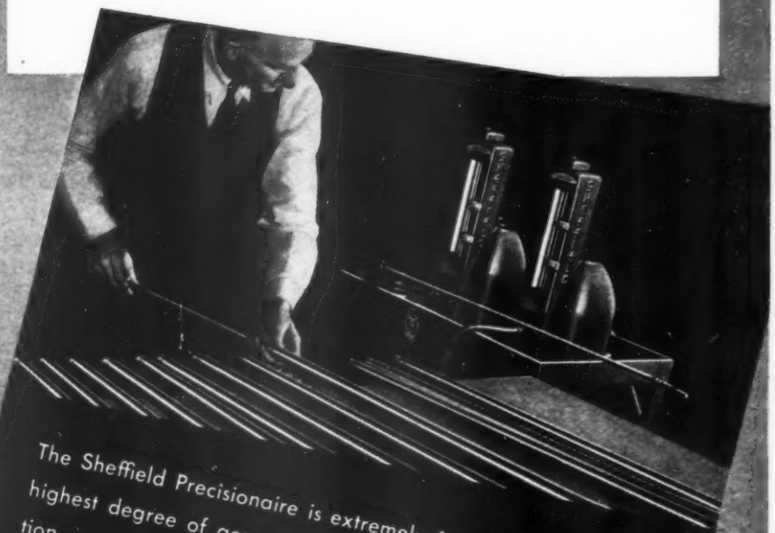
Variable Airfoil. No. 2,273,881. Donald J. Naumann, Inglewood, Calif.—An airfoil having a chamber extending from its trailing edge forward, a flap normally seated within the chamber, roller carriages on said flap, a track comprising rails seated within chamber upon which the carriages are mounted to ride . . . and means for moving airfoil along the track.

(*Turn to page 220*)

Use the
PRECISIONAIRE
to Gage Internal Diameters

Gun Barrels—All Calibers
•
Gun Barrel Rifling
•
Connecting Rod Bearings
•
Piston Pin Holes
•
Step Holes—Several Diameters
•
Cam Shaft Bearings
•
Deep Blind Holes—to Within 1/16" of the Bottom

Work Still on Boring Machine or Grinder
•
Carburetor Bodies and Valve Sleeves
•
Engine Cylinders and Liners
•
Parts Too Heavy to Be Brought to the Gage
•
Bores Too Small to Be Checked Otherwise
•
Highly Finished Bores Vulnerable to Scratching



The Sheffield Precisionaire is extremely fast in action, has the highest degree of accuracy in both process and final inspection—may be used either as a limit comparator for checking tolerance or as an indicating gage for classification of parts. It gives an accurate check not only of internal diameter, but bell mouth, out-of-round and average diameter.

Write for descriptive folder.

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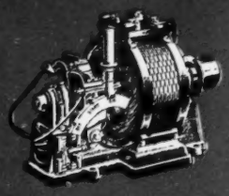
Formerly—The Sheffield Gage Corp.
Gage Division · DAYTON, OHIO, U.S.A.

SHEFFIELD MASTER GAGEMAKERS

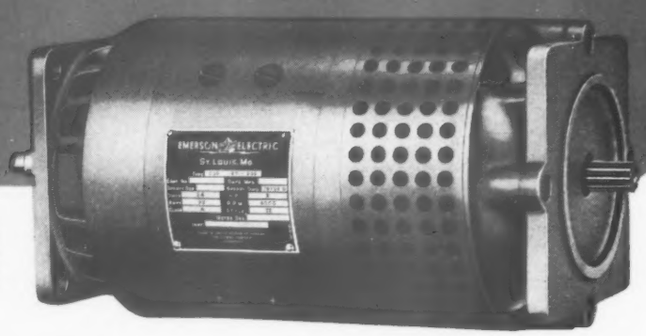


An Early Emerson-Electric Motor—Patented March 7th, 1893

1891 1904 1909 1940 1941 1942

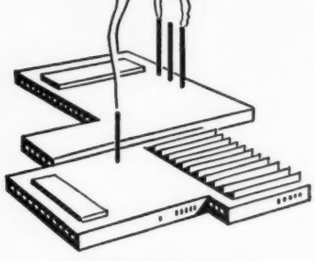
51 YEARS EXPERIENCE BUILDING ELECTRIC MOTORS!

Yours for Immediate Use



SPECIFIC APPLICATION
Emerson-Electric Motor for hydraulic power unit in Airplane Gun Turret. 2 hp. at 4000 rpm 24 volt D. C. Weight 19 lbs.

EMERSON ELECTRIC Offers the Aviation Industry CO-ORDINATED PRODUCTION SKILL AND FACILITIES



FACILITIES FOR QUALITY PRODUCTION

Co-ordinated for high-speed precision production—Emerson-Electric's manufacturing facilities are available for aviation requirements.

THE immediate, direct value to you of Emerson-Electric's 51 years' motor-building experience cannot be estimated—*until you use it!*

Aviation is daily proving this value to itself—turning to Emerson-Electric—presenting problems—getting answers with certainty and speed in terms of motors correctly designed and precision built to do their required jobs.

AIRPLANE MOTORS COMING OFF THE LINE

Emerson-Electric Aircraft Motors are already being produced for Airplane Gun Turrets, Hydraulic Units, Fuel Pumps and Tab Controls; also with built-in gear reduction and limit stop.

Consult Emerson-Electric — FOR ENGINEERING SERVICE — FOR PRECISION-BUILT AIRCRAFT MOTORS!

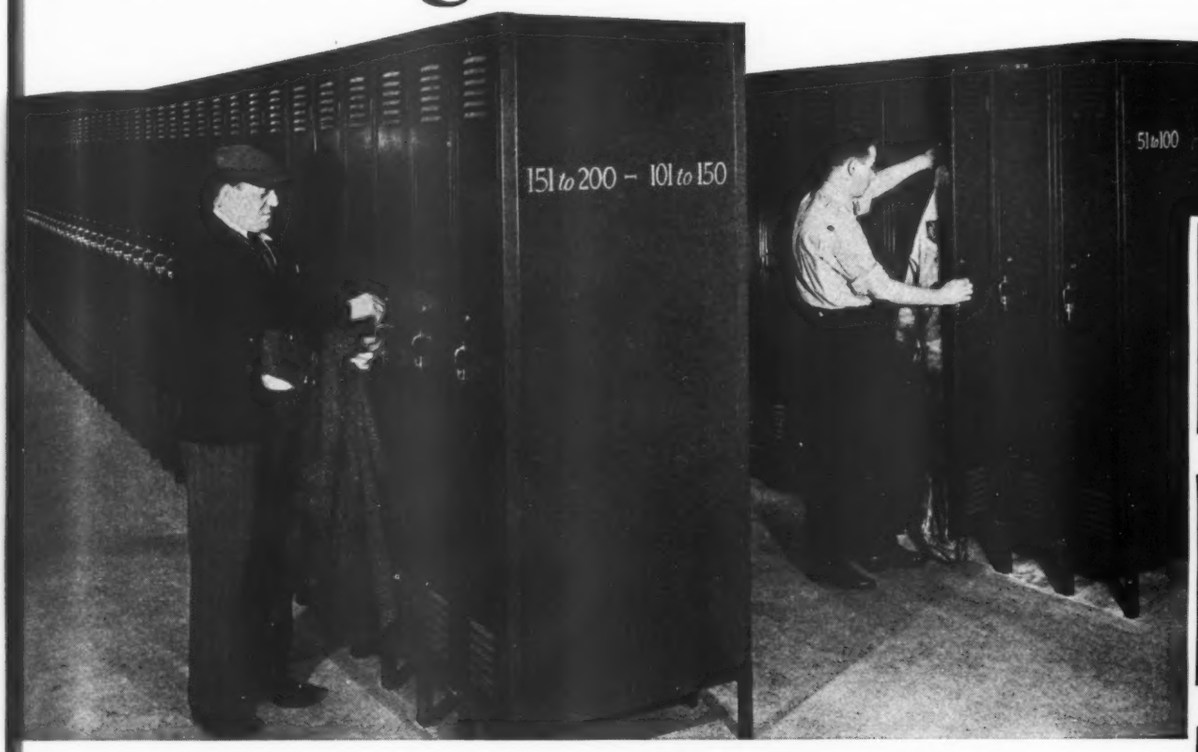
THE EMERSON ELECTRIC MANUFACTURING CO.
ST. LOUIS • *Branches:* New York • Detroit • Chicago

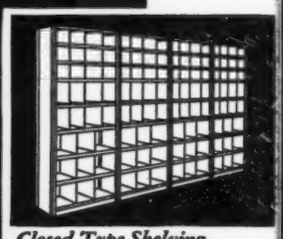
EMERSON ELECTRIC

5 H. P. and Smaller ELECTRIC MOTORS FOR AIRCRAFT 5 H. P. and Smaller

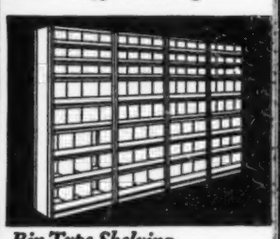
WHEN YOU'RE STRIVING FOR PLANT EFFICIENCY,

Don't Forget the Locker Room



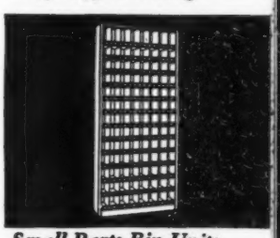


Closed Type Shelving

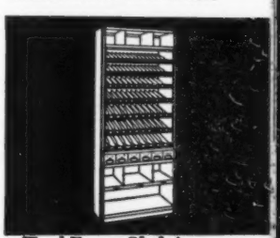


Bin Type Shelving

Ledge Type Shelving



Small Parts Bin Units



Tool Room Shelving

. . . equip it with Berger Steel Lockers

To achieve full speed in war output, a clean, modern locker room is almost as important as good materials, modern machines or efficient systems.

That's where Berger Steel Lockers can help—more than you may think.

Berger Steel Lockers provide safe, easy-to-use, compact storage for employees' clothing and possessions. Like all Berger Steel Storage Equipment, they're strong, fireproof, easy to erect, easy to dismantle and reassemble with high salvage, flexible in layout and long life.

Berger engineers—with more than 50 years of experience—know industrial storage needs. They can design for you the best layout of lockers, shelving, racks, bins, cases and benches for greatest efficiency—to obtain speed in stocking and issuing of materials, parts, tools and dies—to save valuable time in operations—to reduce losses due to damage in storage.

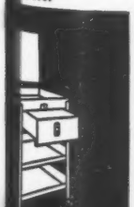
Right now, *Production for Victory* demands all our tremendous output for war industries. If you are engaged in the production of vital needs, our engineers are ready to assist you immediately, and we shall exert every facility to supply the equipment you need. In any event, we shall be glad to send literature showing the complete Berger line for future use. Write us.

REPUBLIC STEEL — PRODUCTION FOR VICTORY

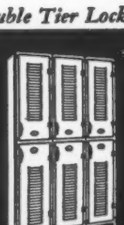
BERGER
STEEL STORAGE EQUIPMENT

BERGER MANUFACTURING DIVISION
REPUBLIC STEEL CORPORATION
Canton, Ohio

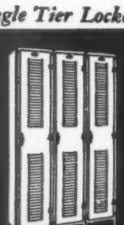
Toter



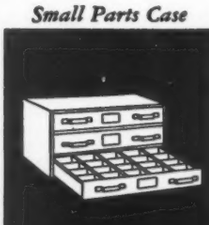
Double Tier Lockers



Single Tier Lockers



Small Parts Case

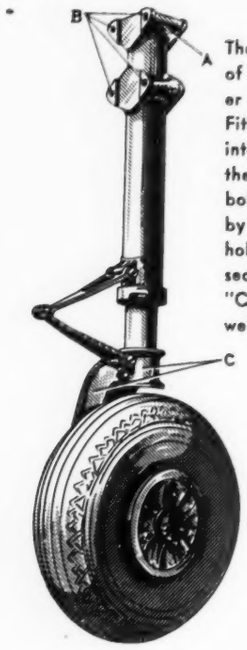


Stacking and Nesting Box

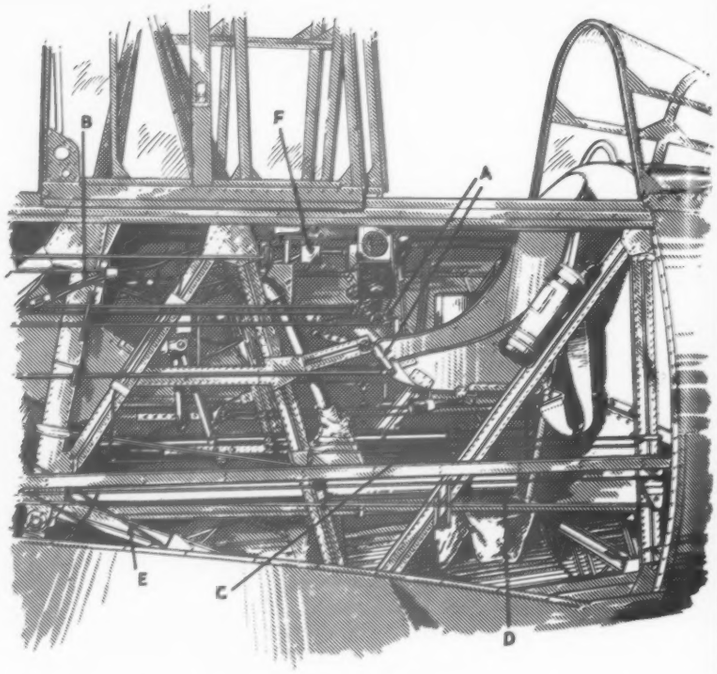
Work Bench

Tool Storage Units

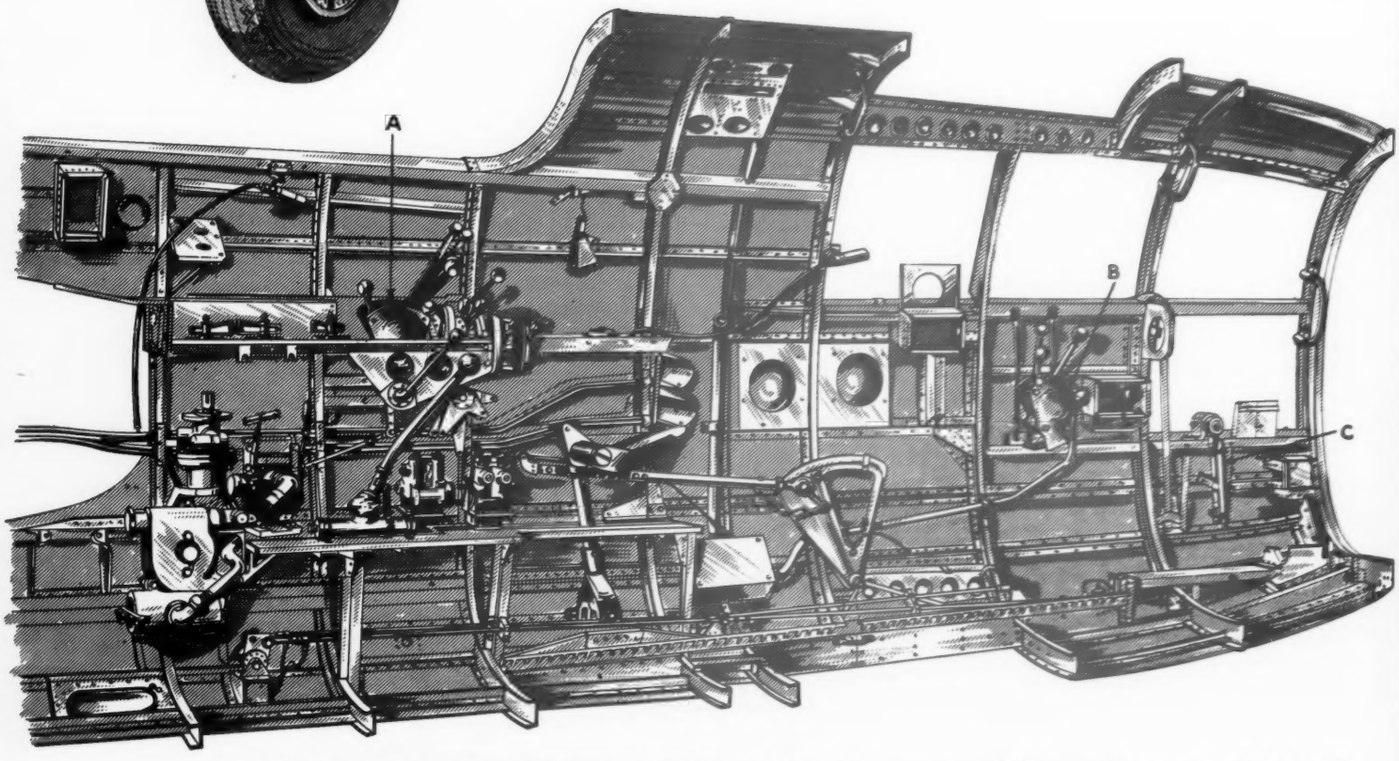
SKETCH BOOK of Design Detail



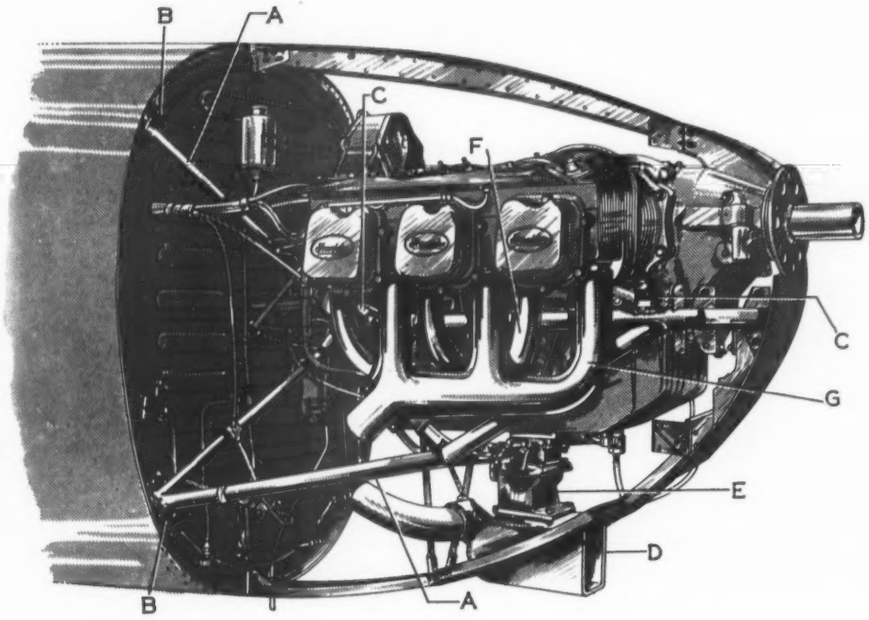
The landing gear, left, of the Fleetwings trainer is of the fixed type. Fitting "A" is inserted into a well structure in the wing. Four through bolts hold it in place by passing through the holes "B". The bottom section of the strut "C" is built up of welded sections.



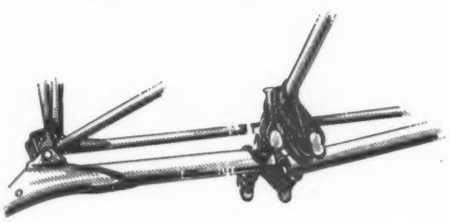
A view of the rear cockpit of the Fleetwings stainless steel trainer, above, shows the engine controls "A" and the electrical conduit "B" to the instruments. Elevator and aileron control torque tube is at "C", while "D" is the hot air cabin heater. "E" is the aileron trim tab control and "F" the selector switch for the radio. Forward position of the switch is for the intercommunication phone, while the rear position is for regular broadcasting and receiving.



On this and on the page opposite are the two halves of the nose section of the Martin 167-W Maryland fuselage, the nose of each half pointing inward toward the other. These two sections, utilizing channel bulkhead rings and riveted dural, are assembled separately in jigs which facilitates the installation of controls and interior parts. The two halves are then fitted together and become a completed nose section. The pilot's controls are at "A". For emergency use,

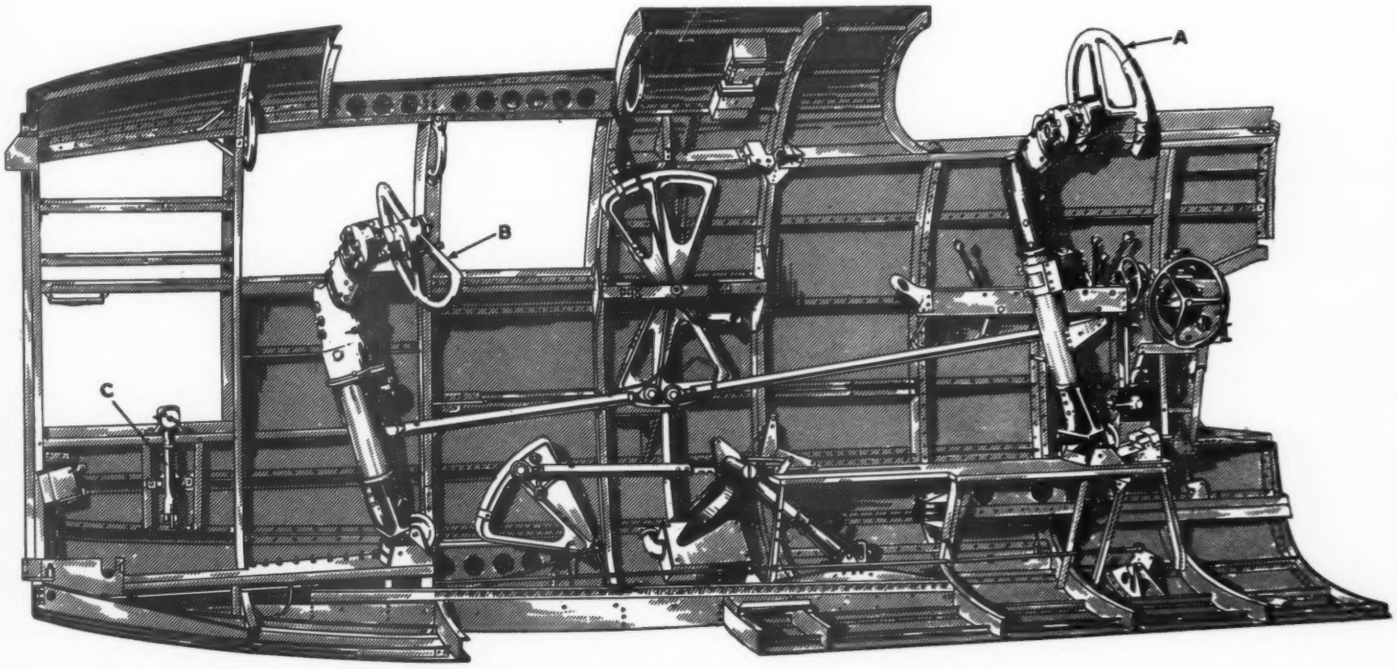


The engine installation, left, in the Fleetwings model 33 trainer utilizes a truss-type, welded steel tubing mount "A". It is attached to the firewall at four points on either side, as at "B", and supports the engine at four points, two of which are shown at "C", through rubber shock mountings. The carburetor air intake is at "D", carburetor at "E", and the intake manifold to the cylinders at "F". Exhaust manifold is at "C".



In the Morton 90-F cabin plane, the main landing gear strut, above, is hinged to the fuselage structure which is welded X4130 tubing. As shown in the drawing, part of the landing loads are absorbed through the flexible shock cord by which the strut ends are attached to the fuselage keel.

The back and bottom of the Vought-Sikorsky VS-44-A pilot's chair, right, is constructed of corrugated aluminum alloy of trapezoidal cross-section. The arms "A" are pivoted to swing back as illustrated by the left arm of the seat. The whole seat is mounted on rollers "B" which run on a track in the floor of the ship.



the controls marked "B" and "C" are operated by the bombardier who sits in front of the pilot. "C" are the pedals which, like the other emergency controls, are hinged, and when not in use are clamped to the side of the compartment to the right of the bombardier. The bombardier, incidentaly, sits on a crew seat which slides forward toward the nose of the bomber, the normal position. Control connections are not all assembled at this stage of construction.

Vought-Sikorsky

Uses VICKERS HYDROMOTIVE CONTROLS

Vickers Hydromotive Equipment is used on many of the most modern airplanes. The Vought-Sikorsky "Corsair" illustrated here is representative.

Vickers Hydromotive Controls are high pressure oil hydraulic controls that are so widely used because they do the job dependably, smoothly and accurately . . . no matter how severe the service.

VICKERS *Incorporated*

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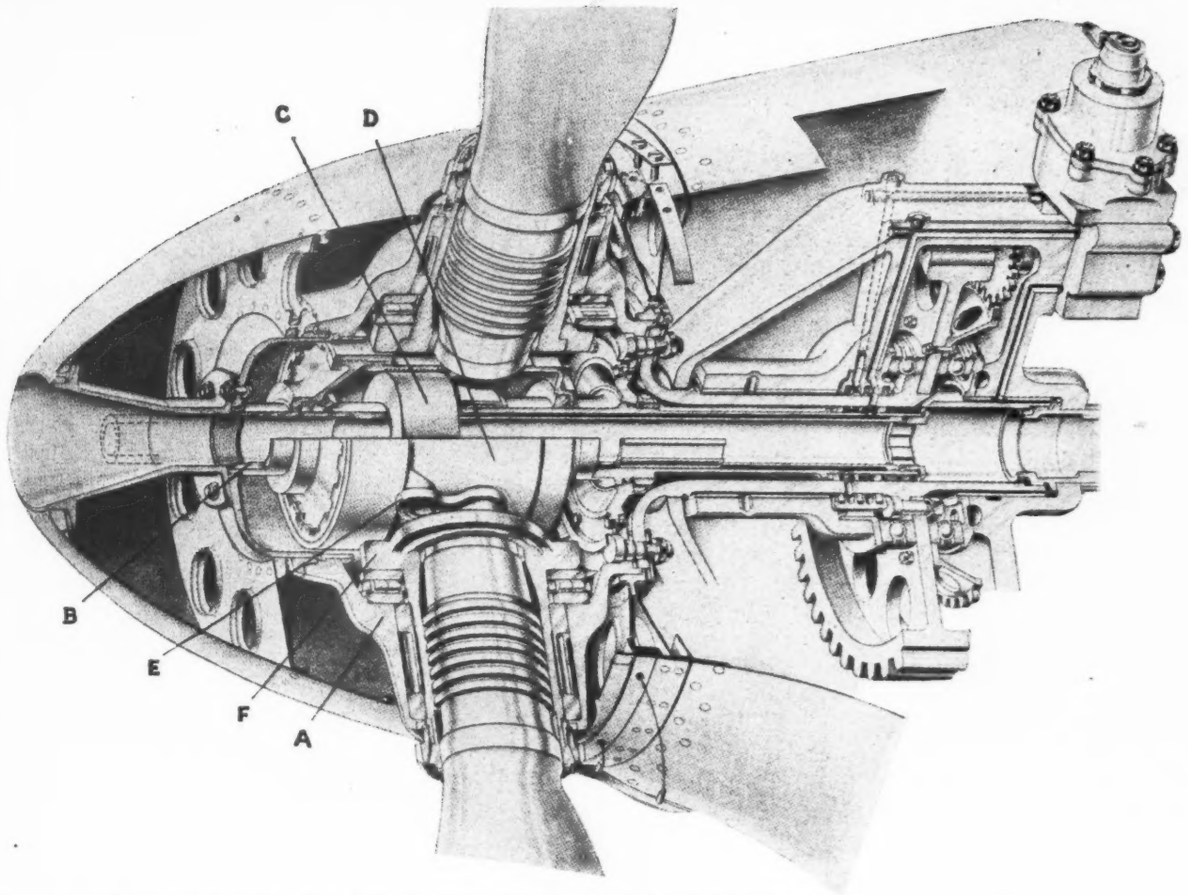
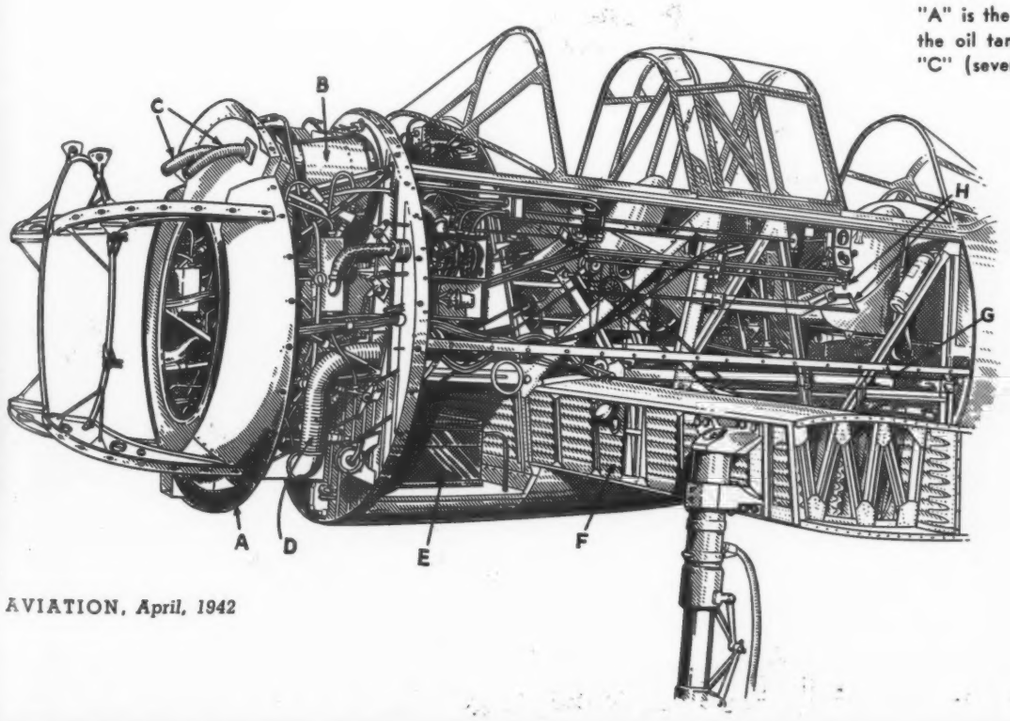
Engineers and Builders
Oil Hydraulic Equipme
Since 1921



Above is a cutaway drawing of the Escher Wyss variable-pitch propeller hub, a Swiss design which operates as follows: The single piece hub-casing "A" encloses all the moving parts and the hollow central tube, "B" which offers the possibility of firing through the hub, and on which is mounted a fixed piston "C". The adjusting cylinder "D" moves over the piston "C" under controlled oil pressure to one or the other side of the piston. This cylinder is automatically controlled by the constant speed governor pump, and reaches either face of the piston through corresponding bores in the central guide tube "B". The locking device is accommodated in the interior of the adjusting cylinder. The connecting links "E" cause direct turning of the blade holder "F". Blades can be unscrewed without dismantling the control apparatus. (See article, page 100.)

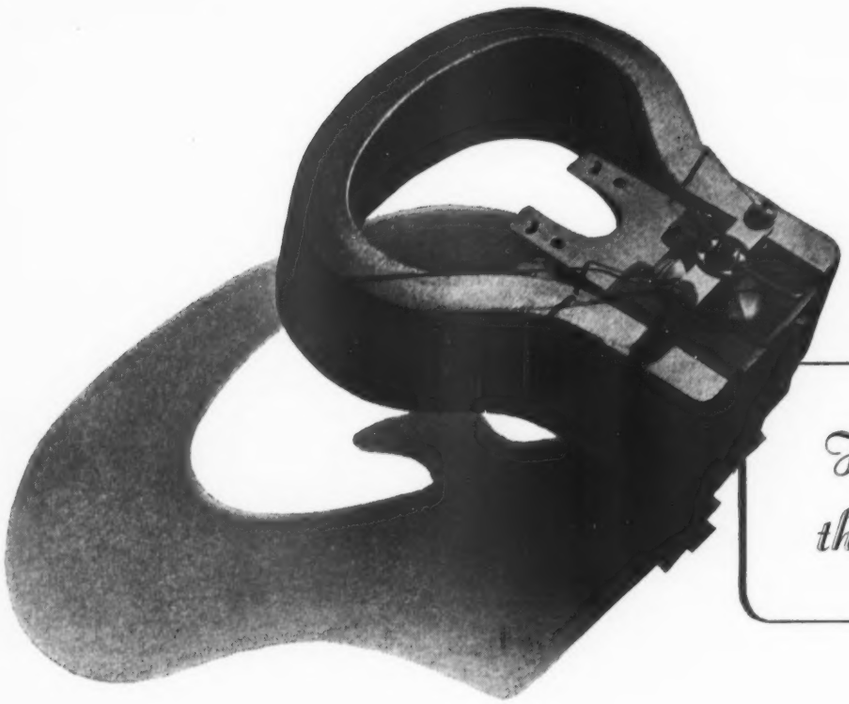


Fleetwings' stainless steel trainer is shown at left. The side fuselage panels, engine cowl and wing nose section have been removed to show the structure beneath. "A" is the engine exhaust cowl and "B" the oil tank with inlet and outlet pipes "C" (severed at the ends in the drawing). The pipe "D" is part of the cockpit heater system which carries hot air from around the exhaust collector ring into the heater pipe "G". "E" is the battery and "F" the fuel tank which is an integral part of the center wing section. Engine controls are at "H" and electric conduit junction box at "I".

AEROQUIP HOSE LINES

AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

AEROQUIP SELF-SEALING COUPLINGS



How accurate the instrument?

. . . HOW PERMANENT THE MAGNET!

So magnets may defy time . . . here they are being *specially* heat treated . . . just one of the many operations in magnet manufacture all under WESTON control to insure lasting permanency and thus provide *lasting dependability* to all WESTON instruments.

"How come," you say, "that so many WESTON Instruments manufactured ten, twenty or even fifty years ago are still giving dependable service throughout industry?"

For the answer . . . first consider the backbone of these WESTONS. Despite their advanced age . . . the magnets have *remained unchanged* . . . the strength of the magnetic field *remained constant.* Neither time, temperature variations, vibration, nor external demagnetizing influences have had any effect. Thus, with their full strength *"kept in,"* errors due to weakening have been *"kept out."*

The secret of the permanency of WESTON magnets dates back over a half century ago . . . when in the middle 80's Dr. Weston established the basic principles of design, and manufacturing control, which first gave the iron horseshoe perpetual magnetic life. And it is these same fundamental principles which still give magnets this essential quality of permanency . . . even when modern materials are employed.

So today, at WESTON, these same basic principles are faithfully carried out . . . to give magnets the *same lasting permanency* . . . to provide the *same life-expectancy* . . . to all instruments which bear the WESTON name. Weston Electrical Instrument Corporation, 616 Frelinghuysen Avenue, Newark, New Jersey.

WESTON

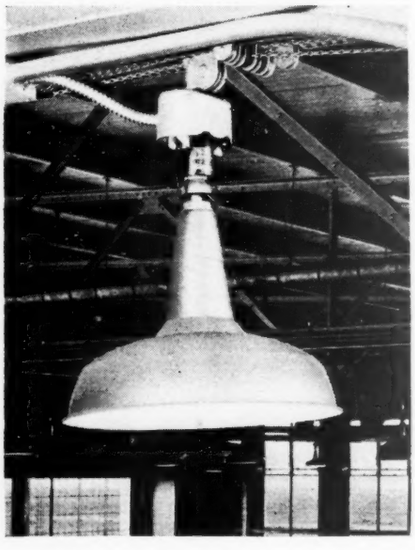
Instruments

AIRCRAFT INSTRUMENTS . . . ELECTRIC TACHOMETERS . . . DC, AC, AND THERMO SWITCHBOARD AND PANEL INSTRUMENTS . . . LABORATORY STANDARDS . . . PRECISION DC AND AC PORTABLES . . . INSTRUMENT TRANSFORMERS . . . SENSITIVE RELAYS . . . SPECIALIZED TEST EQUIPMENT . . . LIGHT MEASUREMENT AND CONTROL DEVICES . . . EXPOSURE METERS . . . DIAL THERMOMETERS

New Products

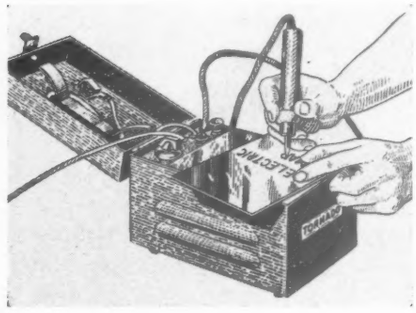
Disconnecting Hangers

With the clearance heights of both military and commercial hangars ranging from 35 to 50 ft. for the larger airplanes, an important development in connection with the lighting of these hangars is the Thompson Disconnecting and Lowering Fixture Hangers. Made by the **Thompson Electric Co.,** 1101 Power Ave., Cleveland, Ohio, the Thompson hanger is essentially an overhead disconnecting switch actuated by the regulated pull and release on a light chain or $\frac{1}{8}$ in. aircraft cable which permits one-man operation. The device has been used by the heavy industries since 1911, but one of the latest developments is the application to obstruction marker lights for use on high stacks, towers, buildings, etc., adjacent to airfields. Company says it may be installed on both new and existing structures at reasonable cost and then serviced with safety at low cost without need of skilled men, or subjecting them to risks formerly involved. For hangar use, the Thompson fixture eliminated necessity of clearing floors so that elevating towers or ladders may be moved into place.—AVIATION, *April, 1942.*



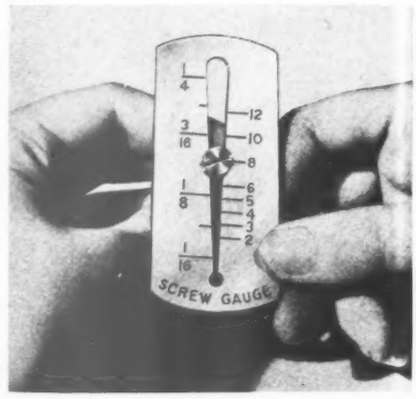
Electric Etchers

Announcement is made of electric etchers of special design now added to their line by the **Breuer Electric Mfg. Co.,** 5100 N. Ravenswood Ave., Chicago, Ill. Made in various models, these etchers are specially adapted for marking dies, tools, and other portable equipment for easy, permanent identification of all smooth-surfaced steel, iron and their alloys. Called the Tornado Electric Etcher, it includes tools, switch, indicator lamp, cords, etc., all of which are contained in a compact, portable case. It is made for both light and heavy etching. A red light tells operator when switch is on, which is turned to desired etching heat. Model A weighs 16 lb.; Model B, 29 lb.—AVIATION, *April, 1942.*



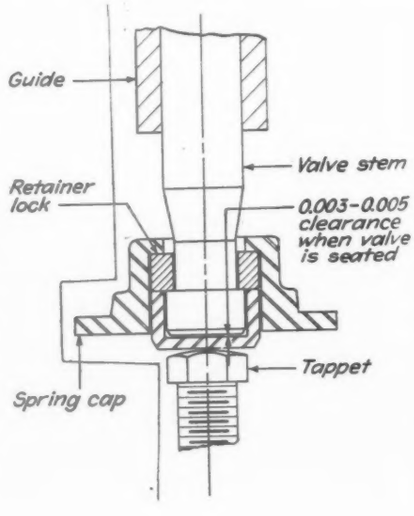
Screw Gage

A handy American National Standard Screw Gage for calibrating both wood and machine screws, in sizes from No. 1 to 12 inclusive, is now being offered for free distribution by the **Dayton Rogers Mfg. Co.,** Minneapolis, Minn. Having two sets of graduations, the one on the left of the angular slot instantly gives number or size of wood and machine screws, while graduations on the right record diameter size of various round stock from $\frac{1}{16}$ to $\frac{1}{4}$ in. Although the gage is graduated in $\frac{1}{16}$ in., a $\frac{1}{64}$ in. graduation is very easily estimated. Gages are accurately made from .165 in. thick good quality flat steel, carefully die cut to size and so finished as to prevent rusting. Free on request on company letterhead.—AVIATION, *April, 1942.*



Thompson "RotoValve"

Designed to prolong exhaust valve life in aircraft engines operating in extreme service conditions, a "RotoValve" has been introduced recently by **Thompson Products, Inc.,** Cleveland, Ohio. A special locking device at the tip, shown in the drawing, permits the valve to rotate slowly in the guide without interfering with normal operation. This device frees the valve stem from the retainer as valve is opened. Forces inherent within in the valve train induce slow rotation, which produces a light lapping action on the valve and block seats. Seat and stem deposits are thus said to be removed before the accumulation at these points



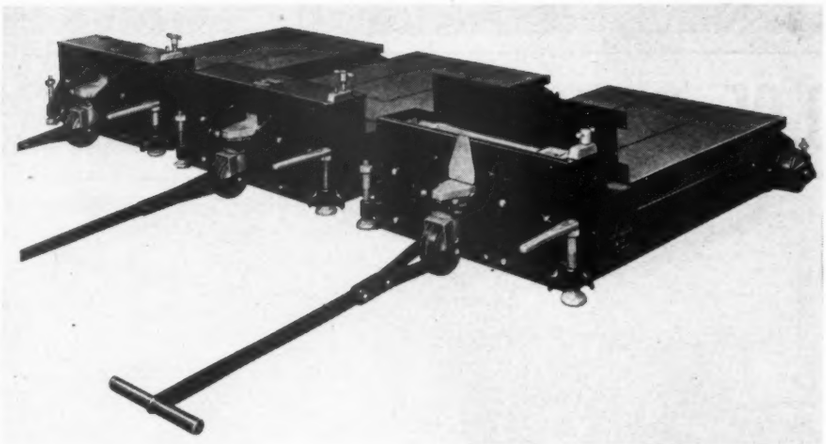
can cause blowby or sticking. In addition, if blowby does exist at the seat due to block distortion, etc., no one point of the valve face is continuously subjected to the high temperature gases, preventing local overheating and guttering of the sealing surface. Dynamometer and road tests are said to have proven this design will increase valve life 2–3 times. —AVIATION, *April, 1942.*

Galvalloy

A new metal alloy, Galvalloy, recently introduced by **Metalloy Co.,** Box 3093, Terminal Annex, Los Angeles, Calif., is reported to obtain a perfect soldering bond with aluminum or aluminum alloys without use of flux of any sort. It is also said to bond practically all types of metals, allowing the bonding of aluminum or aluminum alloys to these other metals. The alloy may be used for many purposes, it is claimed: In foundries where aluminum castings are made for filling blow holes or defects; as a protective coating on welded seams, or other areas where a non-corrosive coating is needed. Under ocean atmospheres after 4,000 hr. exposure, company says no discoloration or corrosion appeared.—AVIATION, *April, 1942.*

"Grass Blitzer"

Operating efficiently at 20 mph., a gang-mower, cutting a swath of 21 ft. 2 in., is said to have the enormous capacity of 46 acres per hour, or 368 acres per 8-hr. working day. Developed by engineers of **Worthington Mower Co.,** Stroudsburg, Pa., the Grass Blitzer is hauled by a fast, powerful tractor, and should be of immense importance to our rapidly expanding air program. The great speed of the mower, allowing frequency of cut, develops a thick, dense turf essential on airfields to keep down the dust during take-offs and landings. In addition, regular cutting tends to eliminate wheel marks in the grass caused by planes which are dead giveaways to enemy observation and which can be photographed from as high as 30,000 ft. The dense turf also helps to absorb rainfall, a factor in preventing water remaining on the surface.—AVIATION, *April, 1942.*

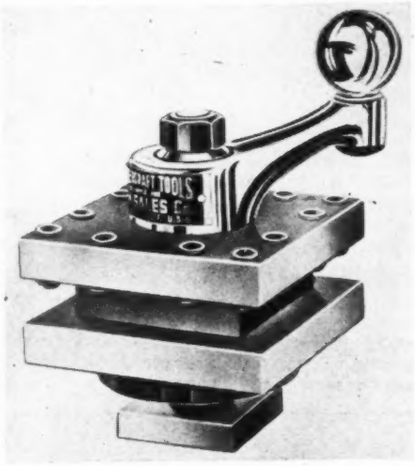


Toledo Scales

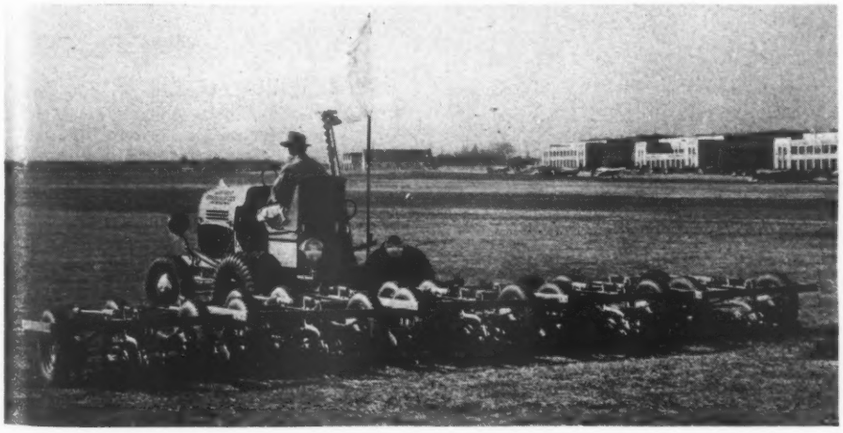
For weighing the future in favor of the Allies, the **Toledo Scale Co.,** Toledo, Ohio, offers a special line of scales to production departments and laboratories of aviation plants. Among the devices comprising the line are the high capacity dynamometer scales which measure torque produced by engine when connected to a dynamometer or other power absorbing instrument. Capacities range from 3,000 to 15,000 lb. Another model, the piston ring testing scales—fan type for diametrical test of piston rings—determines pressure needed for compressing piston ring to certain diameter or tolerance between the ends. Capacity to 30 lb. Others included are combination spring tester scales to test variety of springs in compression and some in tension, which handle, on separate platforms, two classes of springs—from 10 to 150 lb. and from zero to 10 lb.; airplane weighing scales for landing wheels (see photo), rail wheel, nose wheel loads and for entire planes, having a capacity of 10,000 lb.; fuel consumption scales for determining number of revolutions made, and time required, for aircraft engine to consume predetermined amounts of fuel by weight under various load condition.—AVIATION, *April, 1942.*

Improved Turret Tool Post

An improved Mastercraft turret tool post has just been built by **F. & M. Sales Co.,** Hollywood, Calif., who state that this post has been streamlined, lightened in weight for faster action, and includes many new exclusive features. Precision manufacturing methods are said to render all parts interchangeable, permitting user to set aside tool block with all tools in place for future

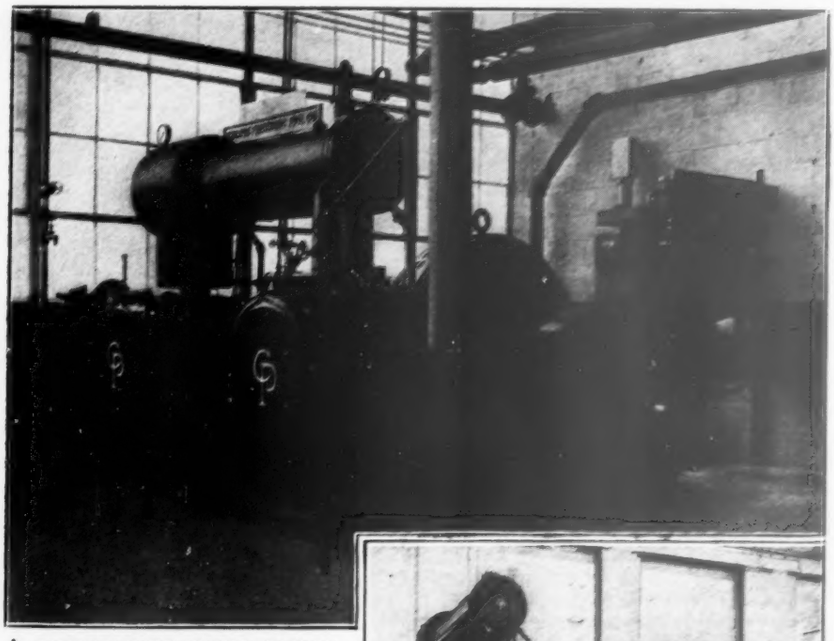


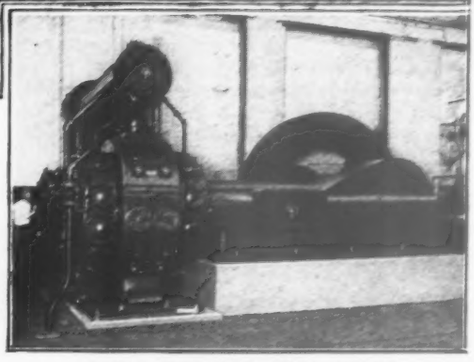
use, while another block is being used on same post. Many difficult tool setups can thus be preserved for subsequent runs with much saving of set-up time, it is claimed. Mastercraft 4-Way Indexing Turret Tool Post is made for use on 10 in. South Bend, 9 in. Workshop, and similar lathes, as well as for small screw machines. Socket screws in place of standard set screws, finish of durable gun-metal, chromium plated handle with swiveling ball are other innovations. To insure accurate indexing in all four positions four precision steel balls are employed in the block.—AVIATION, *April, 1942.*



New Products

O-CE COMPRESSORS TO DEFENSE INDUSTRIES





↑ **SYNCHRONOUS MOTOR-DRIVEN** O-CE Compressor, 800 c.f.m. piston displacement, in a well-known aircraft plant. Simple, efficient, five-step regulation varies the output to meet load.

WITHIN A FEW MONTHS, thirty-five Chicago Pneumatic O-CE Horizontal-Duplex Compressors were installed in well-known shipyards. This popular compressor is available in capacities of 350 to 10,000 c.f.m. →

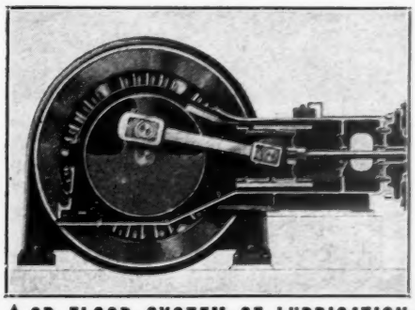
EIGHT 6,000 C.F.M. COMPRESSORS RUSHED TO EASTERN SHIPYARDS

Model Noted For Dependability

NEW YORK—Familiar equipment in aircraft factories, new shipyards and other defense plants are Chicago Pneumatic O-CE Horizontal-Duplex Compressors. Sound in design and ruggedly built, these popular compressors are ideal for continuous, heavy duty operation. The large effective area of their well-known Simplate Valves insures minimum power consumption. Their five-step regulation, low maintenance cost, outstanding reliability and other CP features make them the logical selection for plants which must have dependable, 24-hour-a-day air power.

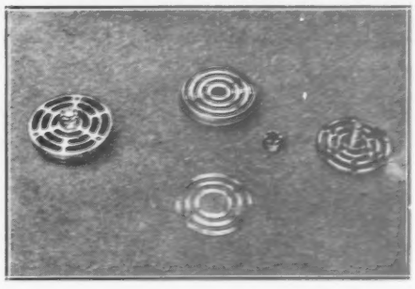
CHICAGO PNEUMATIC TOOL COMPANY

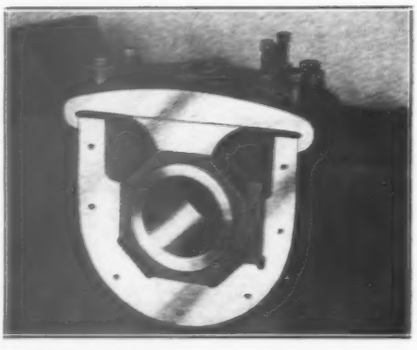
General Offices: 8 E. 44th St., New York, N. Y.



↑ **CP FLOOD SYSTEM OF LUBRICATION** assures maximum reliability. No pump or other working parts to fail and endanger running gear; no small oil lines to clog. This method provides all bearings with a copious supply of oil which also serves as a coolant and returns to the sump to be used again.

ACTUAL MEASUREMENTS PROVE that CP Simplate Valves, with their annular ports and straight, uniform lift, possess the greatest effective area for a given valve diameter, thus assuring lower power consumption. Straight valve lift, together with low air velocities resulting from large effective area, account for ↓ the remarkable endurance of these valves.





↑ **MAIN BEARINGS** of two-piece design are easy to align and adjust—vertically by shims, and horizontally by wedges. Can be adjusted with the machine in operation; can be removed and replaced without lifting out the shaft.

CHICAGO PNEUMATIC

AIR COMPRESSORS

ALSO: Pneumatic Tools, Electric Tools, Rock Drills, Hydraulic Aviation Accessories, Diesel Engines

PORTABLE STATIONARY AIR OR GAS MOTOR DRIVEN STEAM DRIVEN DIESEL ENGINE DRIVEN

Nose to the Grindstone

Around the clock . . . month after month without rest or let up sturdy trainers are being pounded on and off the airports of America. New men are mustered in . . . learn to solo . . . and move up to take their places in the greatest air force the world has ever seen.

In this unrelenting March to Victory Kinner Engines are playing a role for which they have prepared for sixteen years.

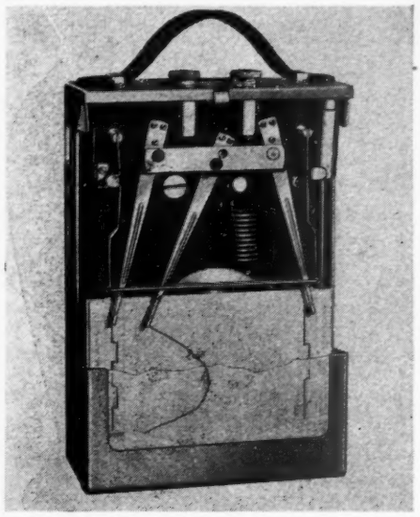
There is work to be done . . . and Kinner Engines have their noses to the grindstone.

KINNER

KINNER MOTORS, INC., GLENDALE, CALIFORNIA

Friez Flight Analyzer

The Friez Flight Analyzer, No. 640, has been especially planned by **J. P. Friez & Sons,** Div. of Bendix Aviation, Baltimore & Central Aves., Baltimore, Md., to chart the altitude of aircraft during flight in terms of barometric pressure. In addition, electrically actuated operations pens record time during which any particular equipment is used. For detailed study of routine airline flight operations, including rate of climb, rate of descent, and employment of navigational equipment, this instrument is said to be valuable. Altitude pen is controlled by Friez evacuated diaphragm with special temperaure compensation. Operations pens are atcuated by electro magnets connected with switching mechanism in the aircraft. These pens are best employed in giving record of operation time of the gyro pilot and radio transmitter but any such "off-on" or "up-down" equipment such as de-icers, flaps, wheels, etc., may be logged, it is claimed. Charts, size of file card, present complete picture of flight data for analysis or meteorological purposes. All accessories are carried within instrument case. Size of No. 640 Flight Analyzer is 8½x5½x2½ in. and net weight is 3½ lb.—AVIATION, *April, 1942.*

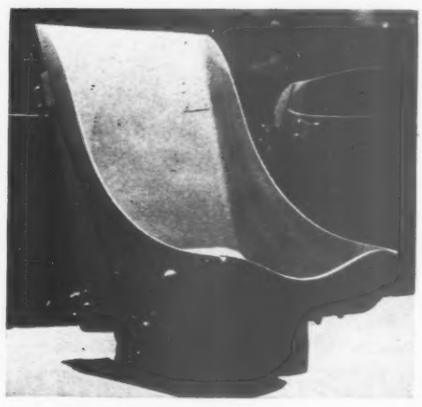


Watson-Stillman Press

An improved 50-ton straightening press is being manufactured by **The Watson-Stillman Co.,** Roselle, N. J. Through use of a manually movable work table 4 ft. long and 14½ in. wide, with a travel of 24 in. governed by a large handwheel, work can be quickly and accurately positioned, company says, with resultant reduction of time wasted in moving the piece to be straightened. Machine is used for straightening rods, bars, tubes and structural shapes. It has a 20 in. opening and 14 in. stroke. By sliding work table to extreme end of travel, a 12 in. gap is obtained. Advance speed is 109 in. per min., pressing speed 18 in. per min. and return, 90 in. per min. A single hand lever gives extremely sensitive control. Floor space required is 5x4½ ft.; height is 8 ft. 7 in.; approximate total weight, 12,000 lb. Operation is by an oil gear DHG pump driven by a 5 hp. motor.—AVIATION, *April, 1942.*

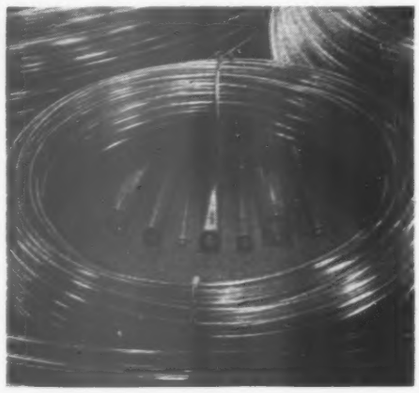
Fletcher Pilot Seat

Approved and in production for installation on Air Corps equipment is a new type pilot's seat being made by **Fletcher Aircraft, Manufacturing Div.,** 625 N. San Fernando Rd., Burbank, Calif. The Fletcher plastic bonded plywood seat is interchangeable with other seats built to AN 7505 specifications, it is said, and because of its plywood construction metal formerly used in seats can be released for other purposes. Aside from metal fittings, the Fletcher seat is made entirely of plastic bonded plywood. Weight and load characteristics are claimed to compare favorably with those of metal equipment. Construction process employs thin veneer laminated at optimum angles. Preforming is said to be entirely eliminated, and the process to retain all the advantages of wood construction including durability and light weight while at the same time providing strength characteristics equal to those of metal. Immediate delivery schedules can be met, firm says.—AVIATION, *April, 1942.*



Tenite Tubing

Transparent seamless tubing, ranging in sizes from ⅛ to ¼ in. in diameter, is now available for immediate delivery, distributed by **Julius Blum & Co., Inc.,** 532 W. 22nd St., New York, N. Y. Extruded in continuous lengths by Extruded Plastics, Inc., Norwalk, Conn., from a cellulose acetate butyrate formula of Tenite produced by Tennessee Eastman Corp., Kingsport, Tenn., the new tubing may be readily bent, formed or curved to fit almost any condition, it is claimed. Weld marks and joints are eliminated in the fabrication of Tenite tubing, and the ends may be adjusted to standard flared fittings with the same tools used for copper tubing. Large diameter tubing, with wall thickness of .0625 in., can be threaded with standard thread-cutting tools. Sizes up to ½ in. in diameter, with wall thickness of .035 in., are stocked in long length coils: over ½ in. diameter is stocked in 12 in. lengths.—AVIATION, *April, 1942.*

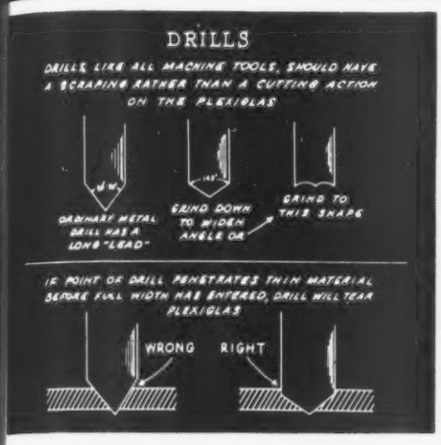


New Products

Fibronized Koroseal Tubing

New electrical insulation for aircraft use is Fibronized Koroseal Tubing designed by **Irvington Varnish & Insulator Co.,** 6 Argyle Terrace, Irvington, N. J. Developed by Irvington's Fibron Division from Koroseal, a Goodrich product, advantages of the new insulation include inside and outside smoothness, exceptional elasticity, and close manufacturing tolerances, makers claim. It is also said

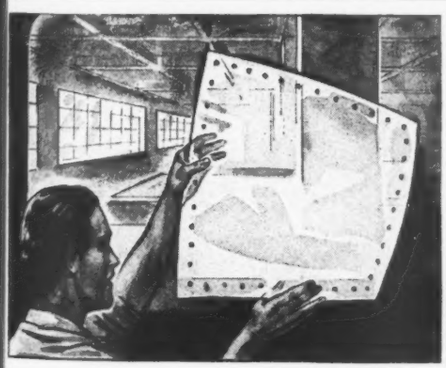
Drilling Plexiglas


DRILLS
DRILLS, LIKE ALL MACHINE TOOLS, SHOULD HAVE A SCRAPING RATHER THAN A CUTTING ACTION ON THE PLEXIGLAS
ORDINARY METAL DRILL HAS A LONG "LEAD"
GRIND DOWN TO WIDEN ANGLE OR
GRIND TO THIS SHAPE
IF POINT OF DRILL PENETRATES THIN MATERIAL BEFORE FULL WIDTH HAS ENTERED, DRILL WILL TEAR PLEXIGLAS
WRONG
RIGHT

Drills for PLEXIGLAS *should be ground with very little "lead" to reduce danger of tearing the plastic.*

The new 48-page PLEXIGLAS Fabricating Manual explains this fabricating tip and suggests hundreds of equally valuable short-cuts for speeding the production of PLEXIGLAS military, naval, and defense units.

As pioneers in the field of acrylic plastics, Rohm & Haas is glad to pass along this information so that each piece of PLEXIGLAS can play its full part in the defense program. Write for your copy today.

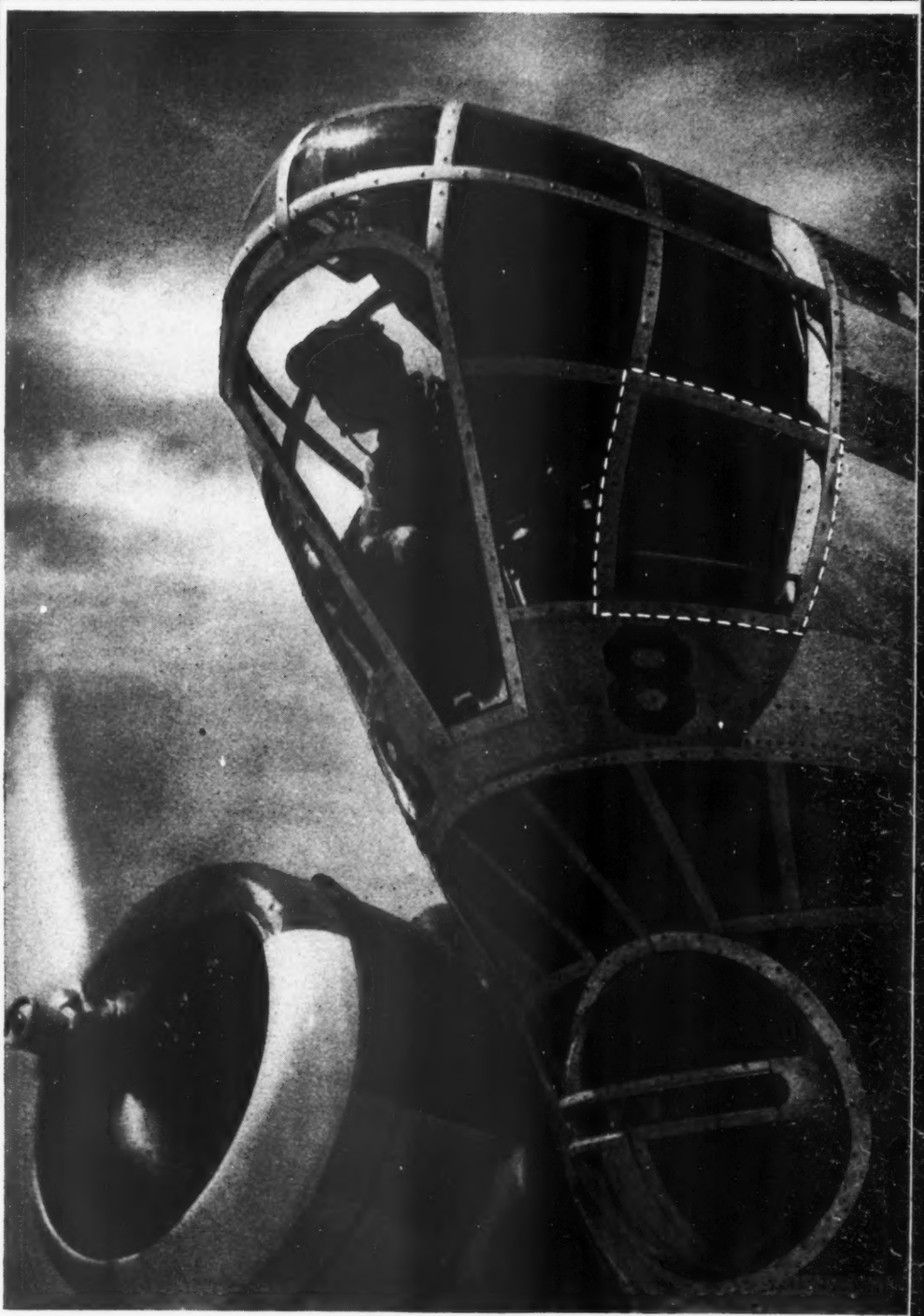


THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS
SHEETS AND RODS

CRYSTALITE
MOLDING POWDER

PLEXIGLAS *and* CRYSTALITE *are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by the Rohm & Haas Company.*



THIS picture graphically illustrates the tremendous importance of permanently transparent PLEXIGLAS *in modern aircraft. Through clear* PLEXIGLAS *sections that are able to withstand the most powerful air pressures the bombardier of this Douglas bomber enjoy maximum vision in every direction.* PLEXIGLAS *is aviation's standard transparent plastic*

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Leather and Textile Specialties and Finishes . . Enzymes . . Crystal-Clear Acrylic Plastics . . Synthetic Insecticides . . Fungicides . . and other Industrial Chemicals

To concentrate on

FIGHTING POWER

White-Rodgers offers entirely new developments in *automatic temperature modulation equipment* for the control of —

1. **ENGINE COWL FLAPS (BOTH AIR AND LIQUID COOLED).**
2. **OIL COOLER SHUTTERS OR FLAPS.**
3. **CABIN TEMPERATURE (BOTH SUPERCHARGED AND NORMAL).**
4. **CARBURETOR AIR TEMPERATURE.**

MAKE THEM MORE & MORE AUTOMATIC!

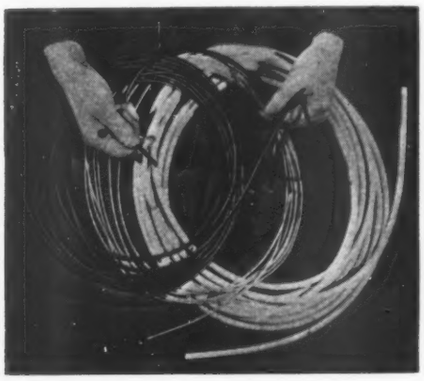
WHITE-RODGERS ELECTRIC CO

SAINT LOUIS, MISSOURI

Official Photo, Courtesy, U. S. N

New Products

to have excellent resistance to acids, alkalis, solvents and heat, to be fireproof and to possess an insulation resistance of infinity after 16 hr. at 90 percent R.H.



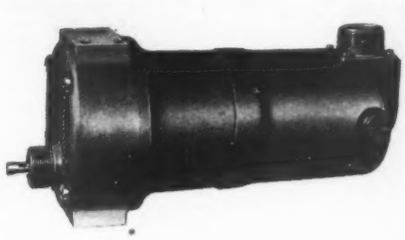
and 105 deg. F. A tensile strength of 2485 psi, a dry dielectric strength (.022 in wall thickness) of 1050 vpm,/a wet dielectric strength of 817 vpm after 24 hr. immersion is also claimed for Fibronized Koroseal.—AVIATION, *April, 1942.*

Lauxein 888 Glue

A self-bonding casein construction glue, called "Lauxein 888" is being used for production of wooden wing spars and tail and rudder assemblies. Manufacturing process involves the lamination of wood with self-bonding construction glue to produce built-up spruce flange members for assembling into truss-like wing spars and tail and rudder parts. Made by **I. F. Laucks, Ltd.,** Granville Is., Vancouver, B. C., special procedures are followed in producing the glue. Before shipping from the plants, specially appointed inspectors must have watched every step of the manufactural and testing operations on each batch of glue, to prevent the slightest deviation from specification requirements. Every keg of glue leaving Laucks plants must bear the approval stamp of one of these inspectors. In the aircraft factories themselves, the glue is mixed in small quantities of about 10 lb. of dry glue each, and mixing procedures and distribution of glue to points of use are rigidly supervised. Specially formulated small lots of this Laucks self-bonding construction glue have gone forward to air training centers for use in repair of aircraft.—AVIATION, *April, 1942.*

New Dumore Motor

An aircraft motor with a rating of ⅛ hp. at 1500 rpm. has been built by **The Dumore Co.,** 14th & Racine Sts., Racine, Wis. Incorporating a magnetic clutch and brake in its design, the clutch disengages the armature from the gears the instant the curcuit is opened and the brake brings the output shaft to stop in a fraction of a second, it is said. An entire series of twelve modifications of the motor, designated E2Y1PC, is available. It can be supplied with the basic motor only; basic motor with clutch; basic motor with single or double gear reductions, and basic motor with single or double gear reductions and magnetic clutch. Possible applications for the motor are cowl and wing flap controls, oil cooler and aerial camera controls. Having an overall length of 8 in. and



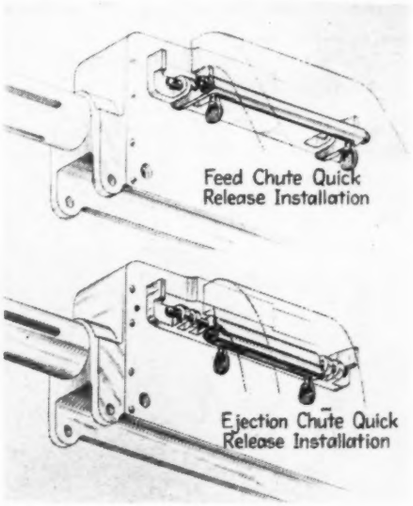
weighing 4 lb., motor is also available with ratings of ⅛ hp. at 1500 rpm.; 1/10 at 200 rpm., and ⅛ hp. at 200 rpm.—AVIATION, *April, 1942.*

Timber-Lock Platform

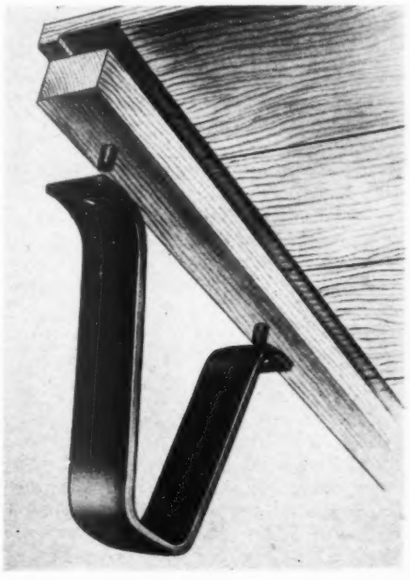
Announcement has been made of a Timber-lock Skid Platform which does not make predominate use of steel. A unique interlocking woodweld process ties supporting leg runners and deck boards into one inseparable unit, manufacture says. The Timber-Lock, built by **Redfield - Johnstone - McNevin,** 142 Chestnut St., Philadelphia, Pa., is of tough oak with hard oak leg beams tightly wedged into deep grooves entire length of platform. Deck and beams are bound together with cement-coated spiralled helical nails at double-rowed 1 in. intervals. Legs are formed steel bars joined to beam by heavy forged steel bolts, and washers on top and bottom of bolts guarantee rigid clamp. Also under the leg bolt heads the large diameter steel washer provides wide bearing point and insures increased leg stability this company states. Available in all standard sizes, plain or armored end, vertical or standard leg design, four or six leg construction.—AVIATION, *April, 1942.*

Gun Chute Clips

Designed to lessen the possibility of jamming and to speed removal of machine gun ammunition chutes for servicing the gun and magazine, a new type quick release ammunition box clip is



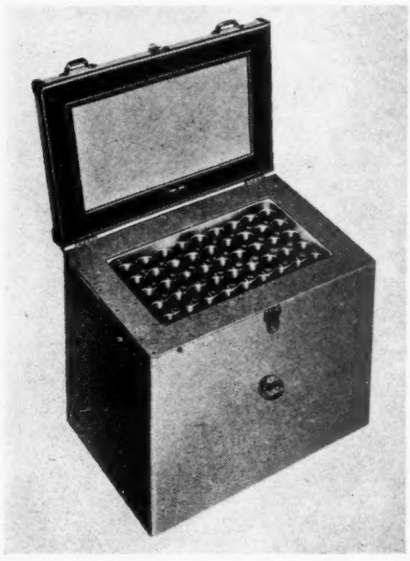
now in quantity production by **Burklyn Corp.,** Los Angeles, Calif. Principle advantage of the Burklyn clips is their



accessability and ease of drawing the pins, even with gloved hands, so that the chutes may be removed from the gun. Design of the Burklyn clips lessens the possibility of jamming, as the ejection chute type clip provides a smooth "bridge" between the gun and the chute, over which the cartridge clips pass more smoothly than with conventional equipment. Units now in quantity production are designed for use with the M-2 .30 and .50 calibre machine guns. They are fixed to the guns and the feed and ejection chute openings by means of the standard gun chute pins. Two spring loaded attaching pins, with finger pads to retract the pins, are contained in the housing. When the finger pads are forced together they release the chutes instantly.—AVIATION, *April, 1942.*

"Cold Treater"

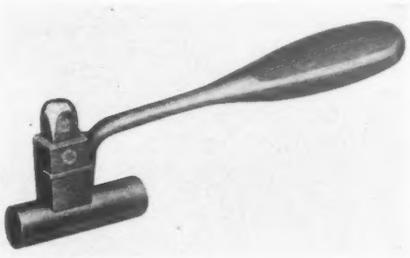
New industrial type sub-zero "Cold Treater" refrigerators maintaining temperatures down to —35 deg. F. for laboratory research and testing, production processing, aging, etc., are announced by the **Jewett Refrigerator Co.,** Inc., 42 Letchworth St., Buffalo, N. Y. Built in 3 and 6 cu. ft. capacities, a large single lid gives complete access to interior of the "Cold Treater" which is equipped with self-contained, trouble-



free sealed condensing unit ready to plug in and use. Standard control maintains temperatures from 5 deg. F. above down to 35 below. Cabinets are available with any specialized types of containers, racks or shelves.—AVIATION, *April, 1942.*

Safe Stamping Holders

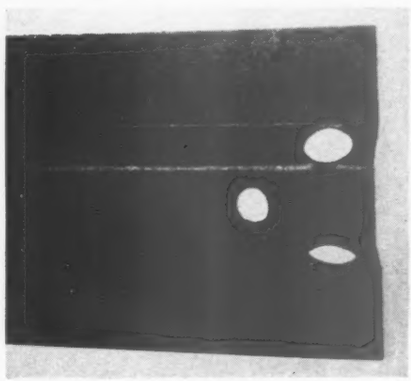
Developed for safety in hammer struck stamp impressions on steel products, **James H. Matthews & Co.,** 3942 Forbes St., Pittsburgh, Pa., announce a steel stamp holding device. War industries required to stamp workmen identification, and other vital data, will find the stamping holder desirable from a time-saver and safety factor, firm says. Adaptable for round or flat products, base of the holder is V-shaped, allowing

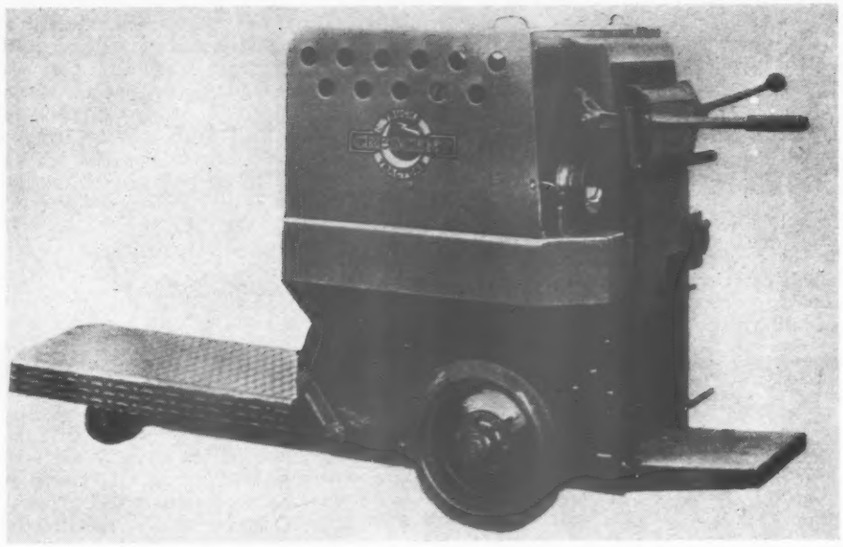


a perfect right angle alignment of stamp when stamping round objects. Held in place by a "Shepherd Hook" holding device, stamp floats up or down in order to find its own location on varying diameters of round or oval shapes.—AVIATION, *April, 1942.*

Airport Center Strip

Another pinch-hitter for the steel so urgently needed in armament is a new center strip for longitudinal and contraction joints in airport runway construction. It is fabricated from asphalt mastic board in designs conforming to current standards and comes in any required length punched as desired for





dowel pins and stake holes. Center strip has high tensile strength which facilitates handling on the job and provides a waterproof seal between slabs it is said. **Keystone Asphalt Products Co.,** 43 E. Ohio St., Chicago, Ill., further claims that the material will not rust or deteriorate after years of service.—AVIATION, *April, 1942.*

Crescent Truck

Plants requiring lift-truck facilities may find type "LDLF" of the **Crescent Truck Co.,** Lebanon, Pa., economical in cost and operation. This lift-truck for use with 7-in. hand-truck skids, is said to replace three to five hand truckers at a cost of one-third the wage of a laborer. Truck is operated by running platform under skid; several pumps on foot pedal raise skid a full three inches; load is lowered by means of release lever on dash, controlled by hydraulic check. This 2,500 lb. capacity mechanism, according to manufacturer, is available at little more than half price of other lift trucks.—AVIATION, *April, 1942.*

H-B Relay

Completely redesigned and improved to insure long life under severe conditions, a silent mercury plunger relay has been announced by the **H-B Electric Co.,** 2530 N. Broad St., Philadelphia, Pa. Three important gains are said to result from the new design: The metal cap and support frame that held the mercury tube were eliminated, thereby releasing strategic materials for other war purposes; the mercury tube was

The B.F. Goodrich Airplane of the month

The BOEING FLYING FORTRESS

EVERYONE in touch with today's swift-moving events is familiar with Boeing's famous B-17 Flying Fortresses. Their great range—their tremendous speed and bomb-load capacity play a vital role in Democracy's battle. High above oceans, deserts, and mountains, these superb aircraft are carrying the fight to the backyards of dictators.

Like many of our country's foremost military aircraft, the Flying Fortresses are B. F. Goodrich equipped. In the air, B. F. Goodrich De-Icers and Bullet-sealing Fuel Tanks improve their performance. During take-offs and landings, Silvertown Airplane Tires and Expander Tube Brakes increase their safety of operation.

More than 80 B. F. Goodrich aviation products are now in use on American military airplanes. B. F. Goodrich is also helping our commercial pilots increase the safety of flight. B. F. Goodrich salutes Boeing — makers of the B-17 Bomber.

Boeing Flies with

B.F.Goodrich

FIRST IN RUBBER

No. 2 of a series

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

How Expander Tube Brakes improve a pilot's ground-control!

IN THE EARLY DAYS of flying, aircraft brakes were patterned after automobile brakes. They were heavy—brake shoe clearances were not uniform, leading to uneven wear and a tendency to grab. Repairs and adjustments were needed frequently.

When B. F. Goodrich developed the Expander Tube Brake, it was hailed as an important contribution to the entire aviation industry. Greatly improved controllability of planes taxied against cross winds . . . take-offs and landings that are safer, smoother, have resulted where planes are equipped with E. T. Brakes.

How the E. T. Brake Operates

The Expander Tube Brake is attached rigidly to the wheel axle in service. It consists of a series of curved brake lining blocks that form a complete circle. These blocks are expanded radially to engage the inner surface of the brake drum, which is attached to the airplane wheel and revolves with it.

Immediately inside this circle of brake lining blocks, securely placed between the blocks and brake frame, is a flat band-shaped tube of synthetic rubber, reinforced with fabric. This is the B. F. Goodrich Expander Tube. The Expander Tube has a collapsed inner cavity extending across the entire tube which is connected to a hydraulic fitting.

Application of the braking fluid under pressure causes this B. F. Goodrich Expander Tube to expand uniformly under the full circle of brake lining blocks. When these blocks are forced against the revolving brake drum, the plane comes to a sure, smooth stop and completes the landing both safely and comfortably.

The B. F. Goodrich E. T. Brake is equally effective whether the plane is going forward or backward. This feature has proved especially helpful when the plane is parked.

The manufacturers of military and naval planes are specifying "B. F. Goodrich Expander Tube Brakes" in rapidly increasing numbers. More and more of the major air lines are demanding B. F. Goodrich E. T. Brakes on their transport planes . . . they are a favorite of light plane owners everywhere.

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

Airplane landings inside a building make

SAFER LANDINGS OUT-OF-DOORS!

ICK PICTURE of the Expander Tube principle. A rubber be fills with fluid and expands. This presses the curved ke block units into contact with the brake lining. ntact is effected smoothly and evenly *all around* the ke drum.

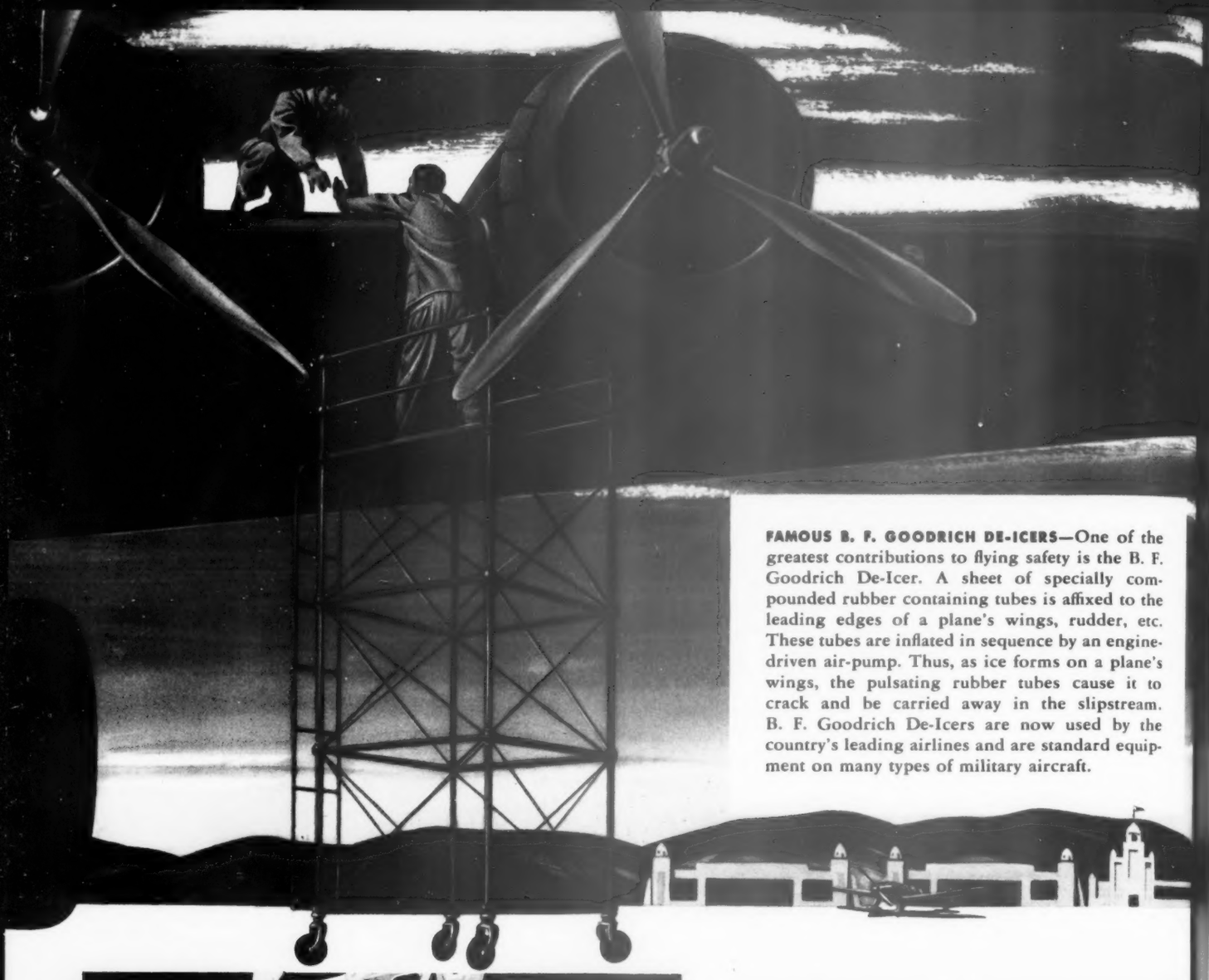
AKE-TESTING MACHINE developed by B. F. Goodrich engineers has not only been responsible for many improvements in E. T. Brakes . . . but was actually responsible for development of the brake itself. Wheel and brake to tested are attached to a swinging arm. Road wheel tates at adjustable speeds and loads. Mounted e is landed against rotating road wheel, thus nulating impact of a plane's landing. Brake is plied and instruments record pressure on brake, rque, and deceleration. This machine has been extreme value in the development of safer, more icient E. T. Brakes. A new brake-testing maine, the most modern ever built, is now under nstruction in the Goodrich laboratories.

EXPANDER TUBE TESTER! With wartime activity extended over areas ranging from great heats to sub-zero weather, a question of vital importance is "How does temperature affect the E. T. Brake?" To supply the answer to this, B. F. Goodrich engineers pioneered with this machine. An electrically heated coil was constructed with temperature controls between 70° F. and 800° F. To test for low temperatures, an ice bath was developed which had temperature ranges from 70° F. to 50° F. below zero. Pressure on the Expander Tube can be varied from 0 to 500 lb. per sq. inch. The never-ending search for aeronautical information such as this is what makes B. F. Goodrich truly "First in Rubber."

In war or peace

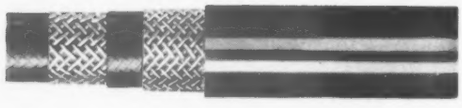
B.F.Goodrich

FIRST IN RUBBER



FAMOUS B. F. GOODRICH DE-ICERS—One of the greatest contributions to flying safety is the B. F. Goodrich De-Icer. A sheet of specially compounded rubber containing tubes is affixed to the leading edges of a plane's wings, rudder, etc. These tubes are inflated in sequence by an engine-driven air-pump. Thus, as ice forms on a plane's wings, the pulsating rubber tubes cause it to crack and be carried away in the slipstream. B. F. Goodrich De-Icers are now used by the country's leading airlines and are standard equipment on many types of military aircraft.

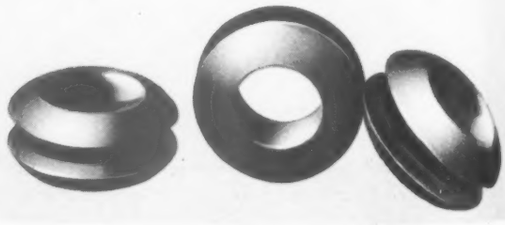
B. F. GOODRICH SILVERTOWN AIRPLANE TIRES are built throughout with Duramin, the B. F. Goodrich "Tire Vitamin" that greatly increases the stamina of rubber. Today thousands of pilots are making their "three points" on Silvertown Tires in planes of all types . . . from light two-place trainers and private planes to huge commercial and military four-motor aircraft.



B. F. GOODRICH FUEL AND OIL HOSE is made with a synthetic tube and two braided inserts. The synthetic rubber is gasoline resistant, and prevents peeling and swelling.

★ ★ ★

B. F. GOODRICH GROMMETS are designed to carry fuel lines and control cables through the fire wall and bulkheads; to allow entrance of the control cables through the fuselage; and for many other places where it is desired to absorb the vibration of cables and wires.



B. F. GOODRICH · AERONAUTICAL DIVISION · AKRON, OHIO

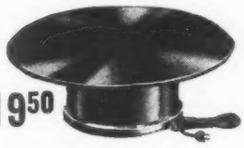
HARTZELL

FULL SPEED
on the road to
VICTORY!

The greatly increased floor space and equipment announced a year ago are being used at full capacity for Hartzell propeller production. Expanded production, but not the slightest let-down in the ideals which have made the Hartzell trademark "a mark of experienced design and honest craftsmanship."

HARTZELL
PROPELLER COMPANY
PIQUA, OHIO, U.S.A.

KEEP FLOODLIGHTS TURNING!



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WITH 48 INCH WOOD TABLE 3 RPM

Roto-sho
ELECTRIC
TURNTABLE

16 inch TABLE
Carries 200 lbs.

48 inch TABLE
Carries 100 lbs. balanced load

All steel 16 gauge

Operates outdoors

Guaranteed 1 year

Self starting

110 A.C. 60 cycles

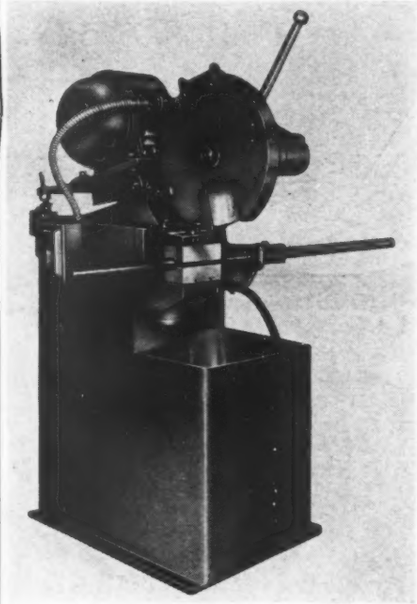
Special Setups to Order

GENERAL
DIE AND STAMPING CORP.
265 CANAL STREET
NEW YORK CITY, N. Y.

made secure by a single metal band which gives twice the stability of the previous design, and, third, the area for terminal fastening and connecting was tripled, thereby simplifying installation and eliminating danger of tube breakage. Said to have been tested to 10,000,000 operations without a failure, it has only one moving part. Unit is available for either a.c. or d.c., and is rated at 30 amp., 110 v., one hp.—AVIATION, *April, 1942.*

Pines Tube Cut-Off Machine

For high production cutting of quantities of tube or rod to the same length, **The Pines Engineering Co.**, 123 Main St., Batavia, Ill., have a new semi-automatic model. The unit consists of a sturdy pedestal on which is mounted a motor driven friction saw or abrasive disk on a swinging carriage. Saw spindle is multi V-belt driven, and both motor and saw, on a welded plate steel carriage, pivot on ball bearing pillow blocks. Limit of carriage travel is controlled by readily adjustable stops. An automatic chuck, which holds tube during cutting, closes automatically as handle on pivoted saw carriage is



pulled down. Chuck is actuated by 4-way solenoid air valve in base of machine. Chuck can be swivelled so as to provide any degree cut up to 45 deg., are available for tubes up to 3 in., and may be changed quickly. Ball bearing motor, 5 or 7½ hp., is connected to starting switch with overload protection. Saw spindle is of high tensile alloy steel.—AVIATION, *April, 1942.*

Turco Slip

A new remover of zinc chromate type primers has been added to the line of cleaning compounds made by **Turco Products, Inc.**, 6135 S. Central Ave., Los Angeles, Calif. Called Turco Slip, it is

CLEVELAND AIRCRAFT LEATHERS
All grades... All types

. . . hold the

SPOT-LIGHT

with

AEROKROME

● In line with current demands, Cleveland Tanning's expansion into the field of aircraft leathers has resulted in the development of a real leader . . . a singularly efficient and attractive leather covering for every aircraft use . . . AEROKROME. This specialized leather product is a light weight, wear resisting, tough covering for seats and sidewalls that is available in a full line of bark or vegetable tanned leathers for upholstering and general covering requirements. And, AEROKROME, may be had natural or finished to meet required colors.

● Knowledge and experience stands behind Cleveland Tanning Aircraft Leathers . . . Cleveland's service to users goes back more than 50 years, and covers all types of commercial leathers. This "know-how" is available to the engineering and production staffs of important defense units. Inquiries are invited—let Cleveland quote on your leather requirements.

50 Years in Leather
CLEVELAND TANNING
Company
SOLE SELLING AGENTS FOR
PLUMER LEATHER COMPANY, INC.
DENISON AVE. & JENNINGS RD.
CLEVELAND, OHIO

STURDY and maneuverable, this shining new Fleetwings basic trainer is a ship that U. S. Army flyers are proud to pilot.

She's got 450 "horses" under her streamlined engine cowling. She's all-welded . . . the world's *first warplane* built principally of *stainless steel!*

Fleetwings engineers . . . who have pioneered in designing and building both airplanes and airplane parts . . . who have developed new techniques for fabricating stainless steel, aluminum alloys and other materials . . . are pleased but not too surprised by the hearty OK accorded the BT-12 by Uncle Sam's birdmen.

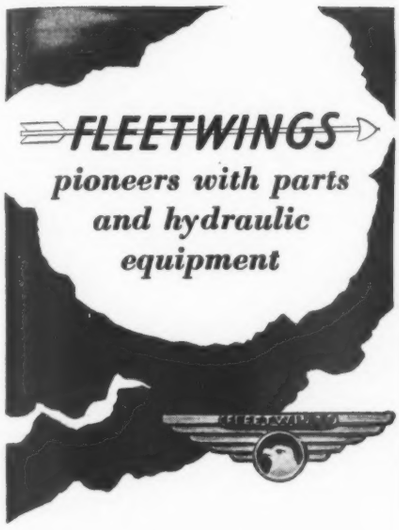
Fleetwings, while concentrating on immediate production jobs, is also active in today's developments that assure bigger, faster, tougher warplanes for tomorrow.

★

FLEETWINGS

Incorporated

BRISTOL • PENNSYLVANIA



Stainless steel ribs for fast warplanes are now speedily formed at Fleetwings . . . more than 15 ribs in one operation . . . on a hydraulic rubber press with four loading stations. Fleetwings production engineers have found this new process even faster than spotwelding fabricated ribs. For other stainless steel parts, Fleetwings' straight-line-flow production system . . . incorporating new mobile jigs and portable, multiple-tonged welding machines . . . has simplified each worker's job and vastly increased output.

To speed spotwelding of Alclad, Fleetwings has developed a new chemical cleaning process for mass-production cleaning of Alclad parts prior to welding. This Fleetwings method permits spotwelding at any time within *three days* after cleaning, and also helps produce consistently good welds. Want details?

"Trifles make perfection, and perfection is no trifle." Making hydraulic equipment . . . fabricating surfaces for leading military aircraft . . . manufacturing fuel tanks, ammunition chutes, turret rings and other aircraft parts . . . these jobs call for maximum *visibility*. Fleetwings engineers have found that by painting all machines, jigs, and other equipment with light gray and bright yellow paints, the improved visibility speeds precision production considerably. This is just one of the "tremendous trifles" that helps Fleetwings get planes in the air faster!

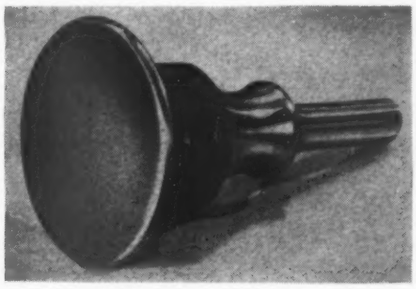
"KEEP 'EM FLYING!"

FLEETWINGS
Incorporated
BRISTOL • PENNSYLVANIA

an alkaline-reacting, water-soluble solvent, largely non-volatile. Said not to attack aluminum and to be rapid in action, functioning on a physical rather than on a chemical basis, Turco Slip promotes cleaning simultaneously with the stripping action, firm claims. Shapes to be stripped should be immersed in solution full strength; the prescribed immersion temperature for stripping aluminum parts is 140-145 deg. F., the action taking three to five minutes. Turco Strip may also be used for stripping prime coats on surfaces too large for submersion in a tank by filling a bucket with the solution from the hot tank and applying it to fuselage or wing sections with swabs. —AVIATION, *April, 1942.*

Aero Tool Swivel Flush Sets

Complete swivel action, for automatic self-leveling when riveting on curved, contoured or level aircraft surfaces, is a



feature of the new Swivel Flush Set made by **Aero Tool Co.**, Burbank, Calif. Perfect flush riveting, even by untrained riveters, is made possible, it is said, by the full swivel action. An extra large 1⅞ in. face on the rivet set combines with the swivel to smooth and iron out, rather than mar or dent skins while riveting. Also, a process known as Microglass Polishing is claimed to produce a mirror-like finish with a scientifically accurate crowned face. Construction is from heat-treated alloy steels. Swivel action is achieved by a lapped ball and socket joint with a tough rubber collar.—AVIATION, *April, 1942.*

Speed Indicator

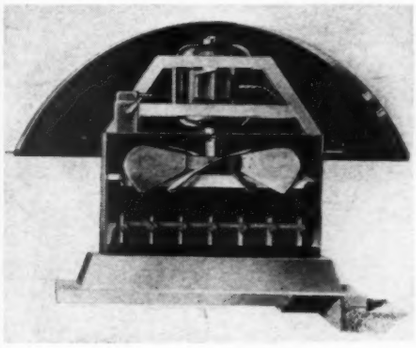
Increasing speed of military aircraft is reflected in the new sensitive air speed

New Products

indicator of 700 mph. range recently devised for the Army by **Kollsman Instrument Div.** of Square D. Co., 80-08 45th Ave., Elmhurst, N. Y. In this new type, the speed in hundreds of miles per hour is indicated by the rotating subdial. The pointer makes seven complete revolutions of the dial for the full range, or one revolution for every hundred mph. Air speed can be read to one mph. at any speed. Kollsman Sensitive Air Speed Indicator is also available in 500 and 600 mph. ranges.—AVIATION, *April, 1942.*

Trane Blackout Ventilators

For wartime blackout plants, **The Trane Co.**, La Crosse, Wis., offers positive ventilation with their Blackout Ventilators. These are available in three basic models: Exhaust unit, Summer Supply Unit, and Winter Supply Unit, each being light- and weatherproof. The Summer Supply Unit is designed to provide large volumes of outside air with perceptible motion at all times. Use of a unit of this type is generally found necessary in large industrial plants or where ventilation for



particular industrial processes is needed. Conventional types of diffusion outlets may be used. The Exhaust Unit has same general design as the Summer Unit, but is an exhaust fan arrangement whereby air in occupied areas is exhausted from the building. In areas in which a tremendous amount of air is being introduced, it is necessary to provide a mechanical means of removing the air, company says. The Winter Supply Unit is designed for application in conjunction with the existing heating system. It contains heating coils, face and bypass dampers, and propeller fan. Said to be easy to install, units include grease-lubricated motors and do not require attention more than every six months. All maintenance can thus be accomplished on rooftop.—AVIATION, *April, 1942.*

PRACTICAL DATA FOR PRESENT PROBLEMS

Here are two books designed to help users of Molybdenum steels and irons to conserve all alloying elements, and possibly steel and iron, by getting the most in the way of strength, toughness and wear resistance with the lowest alloy content.

"MOLYBDENUM IN STEEL" covers the fundamental metallurgy of Molybdenum steels. Heat treatment – physical properties – applications – of a number of these steels are treated at length.

"MOLYBDENUM IN CAST IRON" covers the effect of Molybdenum in gray iron, giving suggested analyses for practical applications and detailed discussion of high strength (60,000 p.s.i. and up) irons.

Both books will gladly be sent free on request.

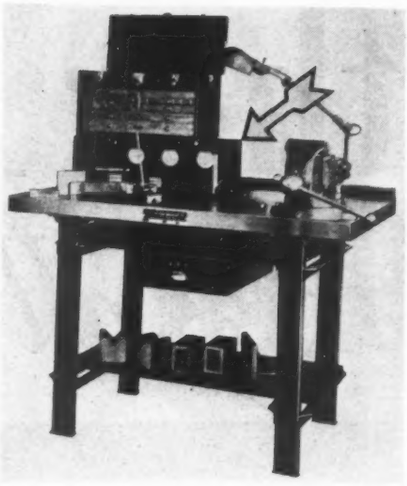
Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

New Products

Challenge Tool Box Shelf

What to do with the tool box on the work bench has been answered by the **Challenge Machinery Co.**, Grand Haven, Mich., with a new tool box shelf for use on Challenge Cast-Iron Top Benches. Shelf provides convenient place for the tool box within easy reach of worker, yet out of the way of his work. Being up above the bench, tool box drawers can be opened without moving anything on bench top, which then becomes almost entirely available as work space. The new shelf can be attached to any new or old Challenge Cast-Iron Top Bench.



These benches are built of iron and steel, solidly braced to remain rigid under heavy pounding, shocks and pressure.—AVIATION, *April, 1942.*

Cabin Trim Interior

The 47th sample card in the current series of suggestions for effectively decorating and upholstering airplane cabin interiors has been brought out by **The Laidlaw Co., Inc.**, 16 W. 60th St., New York, N. Y., in their No. 346. Style #700/845 Chair Upholstery is made entirely of the finest pure wool and will give long, continuous service, firm says. The alternate beige and tan stripes are in good taste. Sidewall & Ceiling Upholstery #10845 is also an all wool broadcloth. The infusion of several colors in this cloth makes a pleasing combination with the chair upholstery and church cloth. Sunfast Curtain Material #5855, one of several colors in company's block pattern, contrasts suitably with the other two upholsteries. Company has supplied the aircraft industry since the first cabin plane was built.—AVIATION, *April, 1942.*

WINDOW SHOPPING

"Caterpillar Diesel . . . On Guard!"—A 32-page booklet that pictures and relates the part played in the victory program by Caterpillar Tractor Co., Peoria, Ill. Request Form 7283.

Aeroscrew—All about screws and bolts; engineering data, dimensions and tolerances, prices per hundred, illustrated with line drawings and photos. Catalog No. 100. Aero Screw Co., 19th Ave. at 12th St., Rockford, Ill.

Facts at a Glance—"Defense Sampler" containing samples of plated metals, listing typical uses for them, and illustrated by means of a chart showing how more strategic metals can be conserved for vital war production. Copies gladly sent to bidders on government contracts. American Nickeloid Co., Peru, Ill.

Time Is Short—Folder describing the Minute Man Method in Floor Maintenance using Flash-Stone, ready mixed, ready to use. Flash-Stone is a plastic which is cold-molded into place and will bond to oily surfaces. Packaged and priced to make a trial no cost consequence. Flash-Stone Co., Inc., 1930 N. 12th St., Philadelphia, Pa.

Electric Remote Speed Indicator—Bulletin No. G-427 on recently developed new type Electric Remote Speed Indicator for use with Reeves Variable Speed Control equipment which still further increases utility of Reeves drives. Reeves Pulley Co., Inc., Columbus, Ind.

Eye Protection—All sorts of goggles and glasses for protection of the eyes in the industry including welding goggles for use in shutting out dangerous infra-red and ultra-violet rays. Kimbal Safety Products Co., 7314 Wade Park Ave., Cleveland, Ohio.

"Marking Devices"—New 8-page booklet summarizing most important styles and varieties of marking equipment offered by firm. Gives technical information to assist users in making most suitable selection for various classes of work. New Method Steel Stamps, Inc., 145 Jos. Campau St., Detroit, Mich.

Precision Aircraft Instruments—Just published, complete 180-page loose-leaf catalog of aircraft instruments containing information on all current types with details of operating characteristics and outline drawings giving instrument sizes and installation requirements. Among new features is identification of Standard Army and Navy types as an aid to selection and standardization. Distribution of catalog restricted to aircraft engineers and others directly concerned with selection of instrument types. More general information available in form of booklet, "Facts About Kollsman Aircraft Instruments." Kollsman Instrument Div. of Square D Co., 80-08 45th Ave., Elmhurst, N. Y.

Priorities and Pyrometers—Clear, concise explanation of how national war program affects purchase, use and maintenance of temperature measuring and control instruments is given in Defense Bulletin No. 1, issued by Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

Trimount — New bulletin describing manometers, meters and gages of various types. Eight-page illustrated booklet. Trimount Instrument Co., 37 W. Van Buren St., Chicago, Ill.

Automatic Temperature Control—Just off the press, interesting booklet explains briefly the principles, and tells of development, of thermostatic bimetals; stresses importance of automatic temperature controls, especially in aircraft which frequently take off in hot desert and in few minutes reach altitudes where temperature may be 60 below zero. Free to engineers responsible for development of automatic temperature control devices. W. M. Chace Co., 1600 Beard Ave., Detroit, Mich.

Drill and Reamer Facts—"Drill Facts" section describes and illustrates design and construction of twist drills, correct drill pointing as well as general suggestions in proper use and care of drills. "Reamer Facts" section contains short treatise on design, construction, use and care of reamers, cause of breakage, excessive wear, etc. Much other useful information. Free to colleges, technical trade, engineering schools and individuals on their firm's letterhead. Whitman & Barnes, 2108 W. Fort St., Detroit, Mich.

Electric Strain Gage—Eight-page booklet describing different types of electrical gages available for measuring mechanical strains and discusses their operation. Well illustrated. GEA-3673. News Bureau, General Electric Co., Schenectady, N. Y.

Airport Lighting—For use in airport lighting design, a new 42-page bulletin, B-3046, covers all the lighting and electrical distribution equipment involved. Prepared in collaboration with CAA, having its approval. Dept. 7-N-20, Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

First-Aid Precautions—Pamphlet presenting first-aid equipment, air raid precautions and first-aid treatments at a glance. B. F. McDonald Co., 1248 S. Hope St., Los Angeles, Calif.

Magni-Ray—Four-page folder fully describing the new Magni-Ray, an illuminated magnifier especially developed for close inspection of all parts entering airplane construction. George Scherr Co., 128 Lafayette St., New York, N. Y.

New Turret Lathe Bulletin—South Bend No. 2-H Turret Lathe described in 4-page letter-size bulletin 67-T. Dept. X5, South Bend, Ind.

"Give Us The Tools"—Catalog presents series of "years-ahead-design" tools for production lines: Aero Tool straight rivet sets, offset rivet sets, flush sets, squeezer sets, bucking bars, dimpling tools, many others. Aero Tool Co., 231 West Olive Ave., Burbank, Calif.

The Bura-Way—Description of a new precision machine particularly adapted for mass production industry. Deals specifically with application of the Bura-Way to single point cutting tools. James Donaldson Co., Inc., 230 Park Ave., New York, N. Y.

Lincoln "Shield-Arc"—Bulletin 412 on self-indicating Dual Continuous Control "Shield-Arc" Welder. Illustrated with photos and charts. Lincoln Electric Co., Cleveland, Ohio.

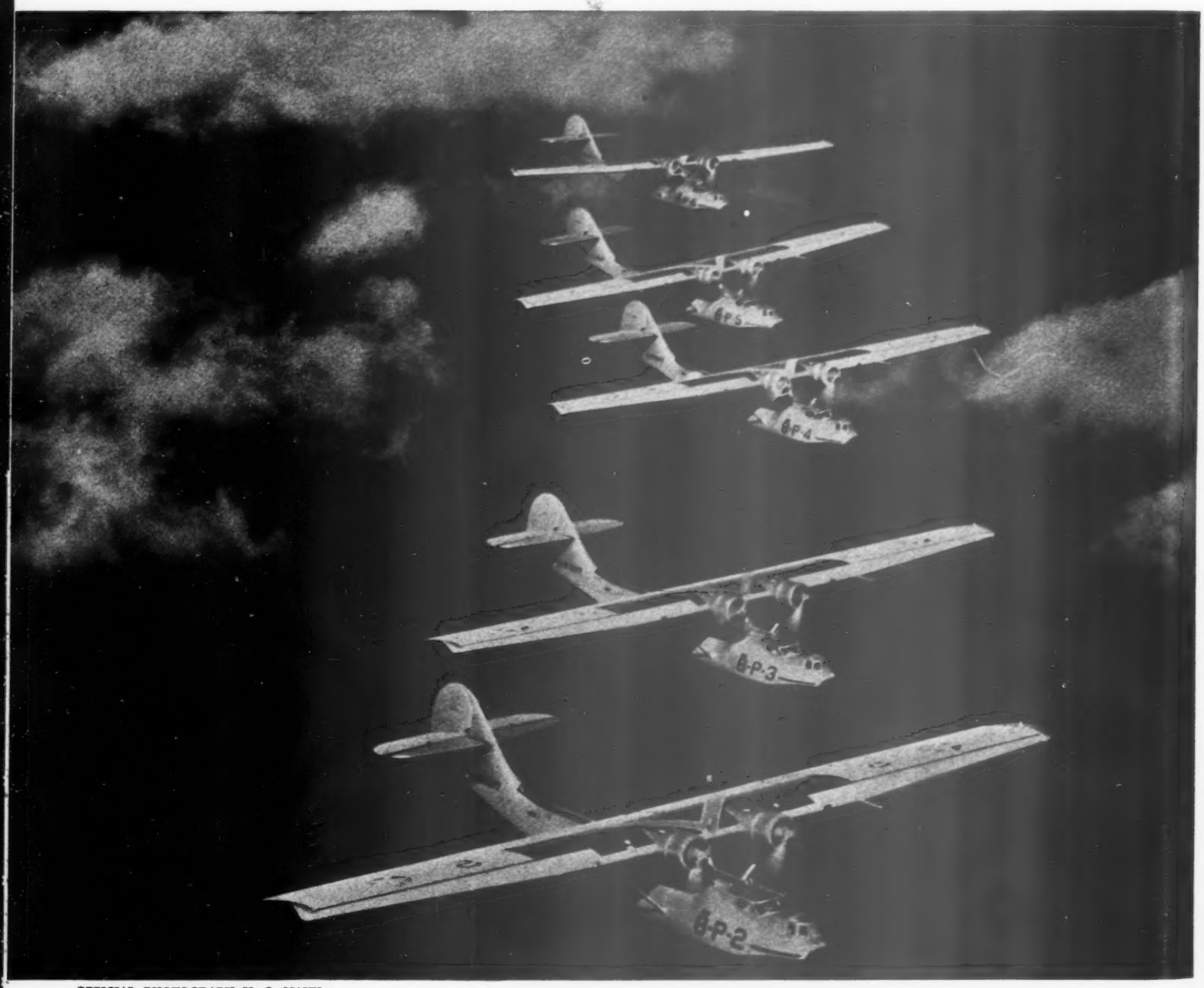
Laminum—Booklet covering history of development of industrial and mechanical applications of laminated shim. Laminum shim can be peeled to required adjustment; no filing, grinding or machining. Laminated Shim Co., Inc., Glenbrook, Conn.

Tool Tips—January, 1942, not only carries current tool tips for which Ex-Cell-O is noted, but also an historical picture of the commodity price movement outlined in chart form from the days of Washington to the end of 1941. Also shown are the national income, business activity, the federal debt, where the family dollar goes. Ex-Cell-O Corp., Detroit, Mich.

Magnus Technical Bulletin—No. 51, devoted to "The Care and Cleaning of Hands and Arms in the Industrial Plant," which should be of assistance in maintaining health through use of planned cleaning routines and cleaning compounds. Magnus Chemical Co., Inc., Garwood, N. J.

Gatke Fabric Bearings—Describes molded fabric bearings of various types for grease or oil lubrication, water lubrication, acid-resisting service, and some unlubricated applications. Included are operating characteristics of the various types with performance results on typical applications. Gatke Corp., 228 N. La Salle St., Chicago, Ill.

No Other Metal Has *all* the Good



OFFICIAL PHOTOGRAPH U. S. NAVY

REPUBLIC *Enduro*

Other Republic products include Alloy Steels—Electrunite* Aircraft Tubing—Upson Bolts, Nuts and

Qualities of Stainless Steel!

Some metals—alloy steels, for instance—possess, among other qualities, high strength and toughness. Some may resist corrosion, oxidation or abrasion. Still others may be readily fabricated and welded. Most metals have one or several outstanding qualities.

But no other metal provides all these qualities in the uniformly high degree found in stainless steel—especially Republic ENDURO* Stainless Steel.

Republic ENDURO provides high strength-to-weight ratio; high resistance to corrosion, elevated temperatures and wear; resistance to stress in sub-zero use. It is easy to weld—may be machined and otherwise worked without difficulty.

For this reason, ENDURO has become one of the essential materials of the Aviation Industry—and more and more of Republic's tremendous capacity as the world's largest producer of alloy, stainless and "aircraft quality" steels is being delivered to plane and engine makers to swell the stream of *Production for Victory.*

Its qualities are helping produce better wing structures, control surfaces, cowling, fire walls, ammunition boxes and chutes, collector rings, supercharger parts, exhaust stacks, air intake pipes, oil tanks, pontoons, radiators and other important parts of our rapidly growing air armada.

Specific details and technical data on Republic ENDURO Stainless Steel, together with information on fabrication and welding, are contained in an interesting series of booklets. Ask us for whatever information you would like to have.

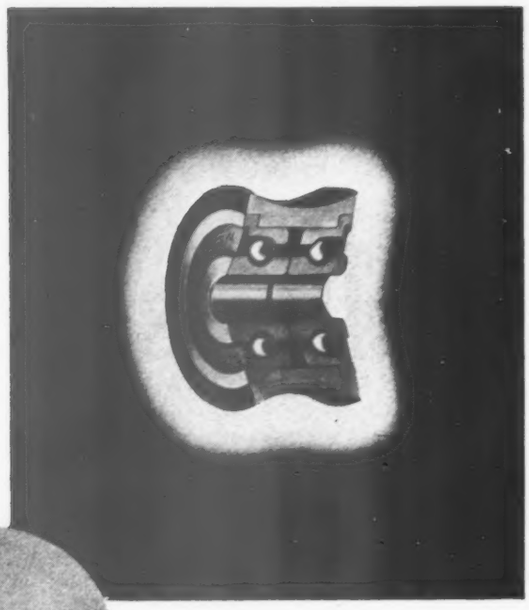
REPUBLIC STEEL CORPORATION

Alloy Steel Division: Massillon, Ohio • General Offices: Cleveland, Ohio
Berger Manufacturing Division • Culvert Division
Niles Steel Products Division • Steel and Tubes Division
Union Drawn Steel Division • Truscon Steel Company

*Reg. U. S. Pat. Off.

STAINLESS STEEL

Rivets—Pipe—Sheets—Truscon Hangar Doors and Building Products—Berger Lockers and Shelving.



SCHATZ
Precision
AIRCRAFT
BALL BEARINGS

SCHATZ PIONEERED IN THE BALL BEARING INDUSTRY • INTRODUCED MANY IMPROVEMENTS IN CONSTRUCTION • ESTABLISHED NEW STANDARDS IN BALL BEARING PRACTICE • THIS SKILL, KNOWLEDGE AND EXPERIENCE IS TODAY REFLECTED IN THE SUPERIOR PERFORMANCE OF ALL SCHATZ CONTROL BEARINGS •

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AVIATION'S

SUBCONTRACTORS SECTION

IN THIS NEW SUBCONTRACTORS SECTION, Aviation offers a service designed to simplify the search for outside manufacturing facilities and thus speed the process of subcontracting.

The production goal of 60,000 military planes during 1942, and 125,000 in 1943, is one of the greatest industrial projects of all time, involving a vast expansion in subcontracting.

It is the purpose of this section to serve as a meeting-place between prime contractor and subcontractor.

Here, manufacturers desiring subcontract work from the aviation industry can make known their facilities, capacity, and ability to serve.

Here, subcontracting facilities may be quickly brought to the attention of firms who urgently need them.

The pages of Aviation have long served as a meeting-place for prime and subcontractors, and we believe this new section will render a greatly needed service demanded by our war-time aircraft program.

C-4351 THERMOSNAP SWITCH—One of many non-adjustable types. Large number of settings available. Immune to shock and vibration.
B-3120—Small thermostat and resistance heater in combination. Used to maintain temperature of small instruments and devices.
TIME DELAY RELAY—Time delays as high as 2 minutes—operates in any position—light and compact—not affected by altitude, shock or vibration.
CABIN CONTROL THERMOSTAT—Close differential—adjustable range—not affected by altitude, shock or vibration.
MORE KLIXON CONTROLS
for Aircraft Applications

Sure—Simple—
Snap-acting—Unaffected
by altitude, shock, or vibration

One of the principal advantages of Klixon Controls is that they are operated by snap-acting thermostatic discs. And this means that they are free from fussy or complicated parts—therefore, simpler in construction, lighter in weight, positive in operation, not affected by vibration, and adaptable to a wide range of temperature conditions. The thermostatic discs used in these controls are scientifically calibrated to give the required performance. And the construction of each unit is made to meet minimum space and weight requirements.

All of these controls have seen service in commercial and military planes since long before "Pearl Harbor" and their proven performance makes them ready and able for applications in the plane you are building for war.

Write for complete information on any of these controls.

KLIXON AIRCRAFT CIRCUIT BREAKERS

These breakers—push button and toggle types—are available in ratings through 120 amps. They have high rupturing capacities—are light in weight—and give complete foolproof protection to aircraft circuits. Send for bulletins containing complete data.

KLIXON
TRADE MARK REG. U.S. PAT. OFF.

Spencer Thermostat Co., Attleboro, Massachusetts

MANUFACTURERS OF THERMOSTATS AND TEMPERATURE CONTROLS FOR AIRCRAFT CABINS, RADIOS, ENGINES AND INSTRUMENTS

10,000 Contractors

Subcontractors to aircraft industry are approaching a total of 10,000 says Aeronautical Chamber of Commerce.

In addition, the work is spread among nearly 20,000 parts and materials vendors. Subcontracting is farmed-out work to be done to specification, while vending is supplying standard parts and materials like bolts, wire and paint.

Principal parts subcontracted are control surfaces, engine mounts, landing gear, wing tips, bomb racks, various mechanisms, seats.

Subcontractors now supplying aircraft companies formerly produced such things as cream separators, sewing machines, printing presses, fishing reels, cans, cameras, vending machines.

In 1941, 248 plants in 80 cities supplied parts for the B-17's. This year many more are involved. Parts for another plane come from 254 cities in 26 states; vendors in all 48 states supply the same project.

An aircraft instrument company estimates that its 145 subcontractors alone do 240 man-years of work a month; the vendors contribute even more work.

Most of the prime manufacturers maintain large engineering staffs to work with the subcontractors. This includes a large program of teaching the former civilian producers the fine tolerances and precision of aircraft construction.

NEW SUBCONTRACTING PLAN

The WPB and National Association of Manufacturers are about to conduct a series of experiments to test the "casting office" plan for distributing war production work in the Chicago and two or three other areas.

The plan's principal feature is a directory of subcontracting opportunities compiled by a central bureau and made available to potential subcontractors each week. All details of materials, weights, numbers, and facilities are taken from the prime contractor's routine operating sheets, set up in code, and sent to Washington for listing in the directory.

The prime contractor specifies in his sheets the type of machinery required to perform the job and describes the essential phases of the operation. The potential subcontractor, having assigned corresponding codes to his machinery, receives the directory each week, looks through it for the code descriptions of his own machinery, and determines whether or not there is a job available for him.

The NAM is understood to be preparing a wide distribution of the details of this plan to all potential subcontractors. Arrangements are also being made for meetings with prime manufacturers in the areas to be tested.

Veterans of the Airlines...

Elastic Stop Nuts hold the wings to the fuselage, on all Douglas DC Series Transport Airplanes. This is but one of the many Elastic Stop Nut applications on these famous ships.

DOUGLAS DC TRANSPORTS and ELASTIC STOP NUTS

Since 1936, more than 500 Douglas DC Series Transport Airplanes . . . in the air 200,400,000 hours . . . have flown over 350,000,000 miles. The meaning of this remarkable record, in terms of safe and rapid transportation, is well known.

One important reason for this performance, and for the fact that these ships are still in top flying condition, is that they are fastened throughout with vibration-proof Elastic Stop Nuts . . . more than 30,000 on each ship.

These self-locking self-gripping nuts are used today, at vital structural and secondary connections, on every military and transport airplane built in the Western Hemisphere . . . and on innumerable other classes of mechanical and electrical equipment . . . including many of America's tools of war.

TEST ELASTIC STOP NUTS on your products and equipment. Sample nuts will be furnished without cost or obligation.

CATALOG ON REQUEST

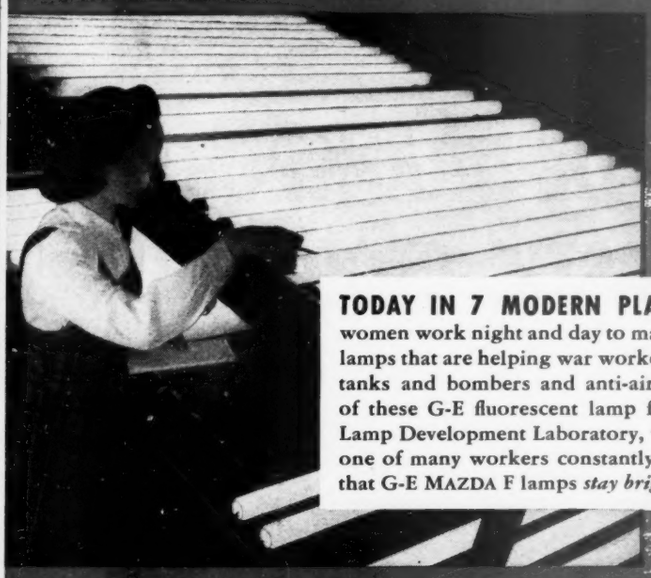
ELASTIC STOP NUT CORPORATION
2320 VAUXHALL ROAD • UNION, NEW JERSEY

Elastic Stop REG. U.S. PAT. OFF. SELF-LOCKING NUTS AND AIRCRAFT FITTINGS

How to pull extra Ma

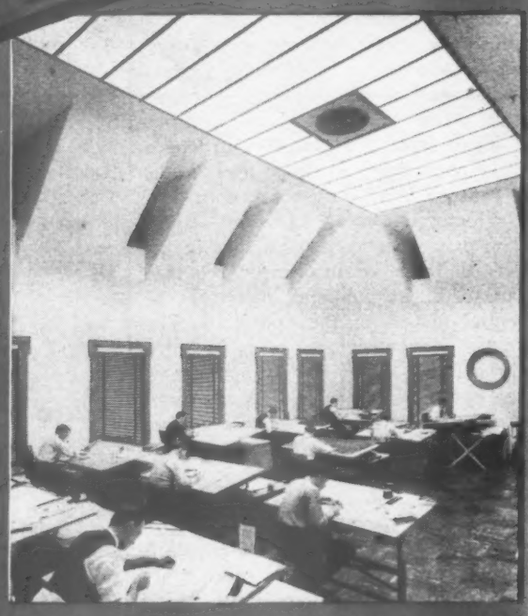
THIS REVOLUTIONARY new kind of lighting is urgently needed in thousands of industrial plants engaged in vital war production. Some of these plants are probably customers of yours. If they can't buy a modern lighting system, show them how to get more out of their present lighting by washing and cleaning lamps and reflectors, re-painting walls and ceilings a light color, and by replacing burned out lamps promptly with G-E MAZDA lamps.

Read how G-E Fluorescent Lighting — Ameri 24-
productive man-hours to wartime industry
preventing accidents



TODAY IN 7 MODERN PLANTS men and women work night and day to make the slim glass lamps that are helping war workers produce more tanks and bombers and anti-aircraft guns. Back of these G-E fluorescent lamp factories is G-E's Lamp Development Laboratory, where this girl is one of many workers constantly checking to see that G-E MAZDA F lamps *stay brighter longer!*

11 MILES OF G-E MAZDA F (fluorescent) lamps were installed in this typical new wartime plant. Officials say inspection of thousands of different parts would be a costly bottleneck in ordinary lighting. But the 5-foot 100-watt G-E MAZDA F lamps in this picture give workmen conditions approaching actual daylight! Show customers what G-E fluorescent lighting can do for them!



THE BATTLE OF 1943 is already being mapped out in industrial drafting rooms like this one, planning heat-treating equipment for armament parts, under cool indoor daylight furnished by G-E MAZDA F lamps. Draftsmen work with less strain, make fewer mistakes, get more done than with ordinary lighting.

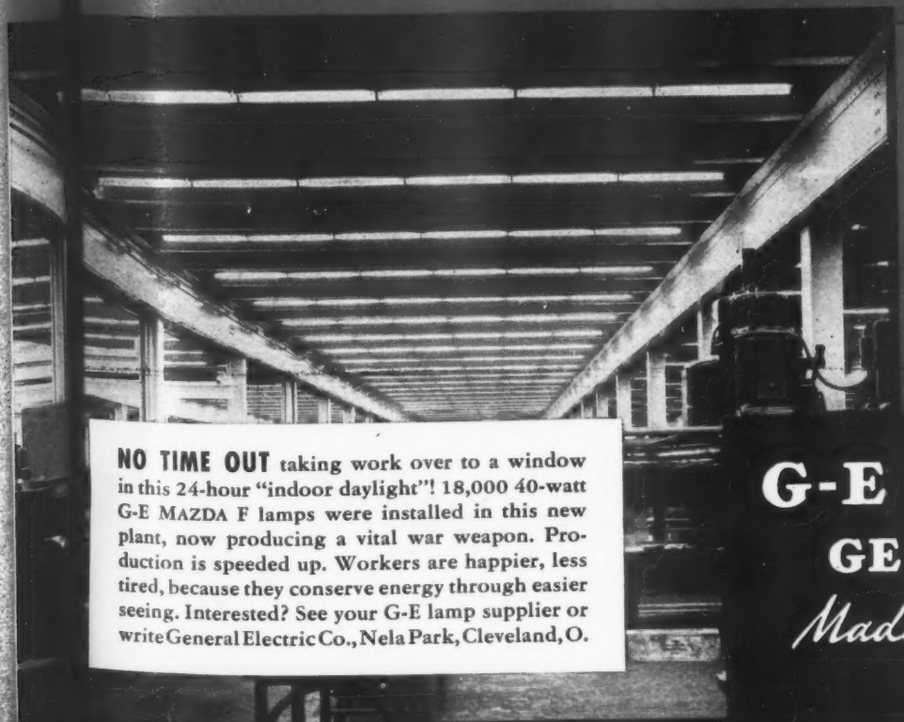
...Hours out of a Glass Tube...

...24-hour daylight — is adding millions of ...ding production . . . reducing spoilage . . . ...king seeing easier

AMERICAN PLANE PRODUCTION reaches its goal, much credit will be due to a ...nd of light. Four-motored monsters like this Flying Fortress are being made faster ...the cool indoor daylight of G-E MAZDA F lamps. But let industry speak for itself. ...reduction in scrapped pieces," says a machine shop. "50% fewer accidents," says ...r. "No time lost hunting good light for micrometer readings," says a machine tool ...turer. Amazingly, results like this are obtained without adding extra floor space, ...ery, or workmen!

30% FEWER HEADACHE TABLETS are needed in one plant since G-E fluorescent lighting was installed. By selling good lighting to your industrial customers, you are helping workers avoid eyestrain, save energy, and do their jobs more efficiently.

EXPERIENCED FIXTURE MANUFACTURERS now make over 100 fluorescent fixtures which are tested and certified by Electrical Testing Laboratories to exacting specifications for good service. Be sure your fixtures carry either the Fleur-O-Lier or RLM label.

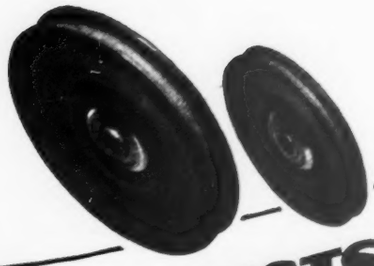


NO TIME OUT taking work over to a window in this 24-hour "indoor daylight"! 18,000 40-watt G-E MAZDA F lamps were installed in this new plant, now producing a vital war weapon. Production is speeded up. Workers are happier, less tired, because they conserve energy through easier seeing. Interested? See your G-E lamp supplier or write General Electric Co., Nela Park, Cleveland, O.

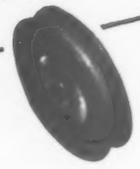
G-E MAZDA LAMPS

GENERAL ELECTRIC

Made to stay brighter longer



RIGID TESTS KEEP QUALITY OF FORMICA CONTROL PULLEYS HIGH!



1 Each pulley is tested for run out that might be due to the bearing being assembled with slight angularity in the pulley.

2 The exact amount of force is determined that would be required to push the bearing sidewise in the pulley. This must exceed requirements.

3 The diameter of the groove in the pulley through which the cable runs is checked along with contour of the base of the groove to be sure the cable will fit.

4 A second test is made for total run out or wobble including any play in the bearing itself, or any inaccuracy in the fabrication of the pulley.

5 Frequent tests are made to determine the amount of force that would be required to fracture the flange of the pulley.

6 A static load test is made on a certain percentage of pulleys to determine the weight and force the pulley will endure without breaking down.

7 Pulleys are also tested on apparatus to determine the breakdown point under fatigue caused by frequent reversals in the direction of rotation.

FORMICA control pulleys for airplanes consistently exceed the requirements of Army and Navy specifications by a wide margin of safety. To make sure that they do, tests have been developed for each quality covered by the specifications and these are rigidly applied to be sure that daily shipments—running in thousands of pulleys—meet the requirements.

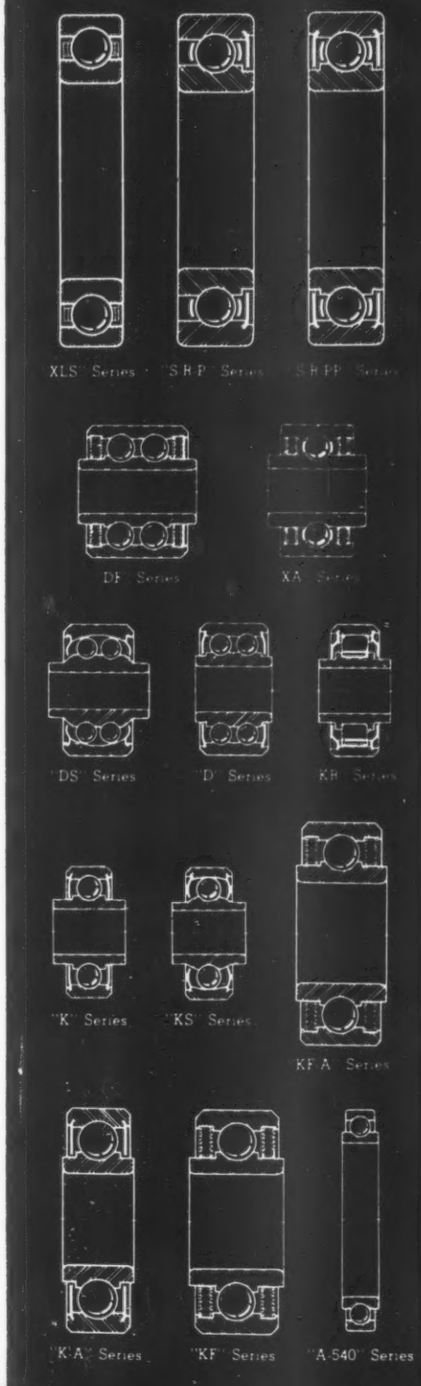
This exactness in manufacture is added to a material that has important fundamental qualities that adapt it to airplane use. It is lighter than metal (specific gravity 1.3). It resists moisture absorption and the dimensional changes that are caused by it; it has a low coefficient of thermal expansion; it is chemically inert and safe from corrosion under a wide range of conditions.

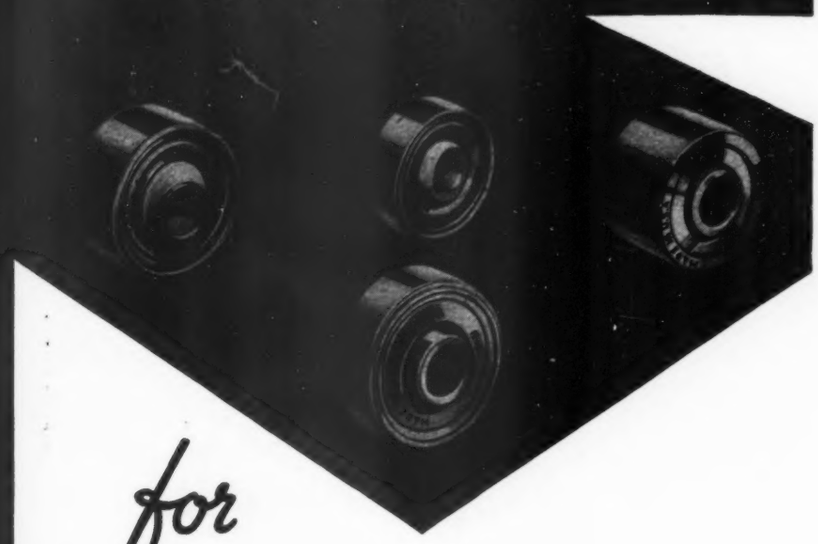
Hence its widespread and growing use not only for pulleys but for many machined parts on nearly all American Airplanes . . . Send for the Formica catalog of airplane parts.

The Formica Insulation Co., 4628 Spring Grove Ave., Cincinnati, O.

FORMICA

"NORMA-HOFFMANN"
PRECISION BEARINGS





for

AIRCRAFT CONTROLS

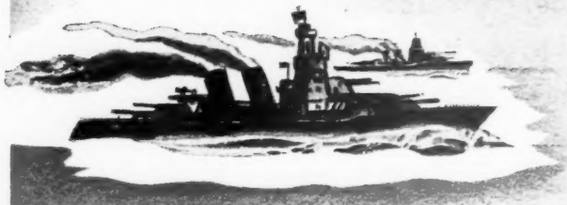
Identified with the aircraft industry from its earliest days, NORMA-HOFFMANN pioneered many of the important bearing types now accepted as standard in aviation practice. * * * * Today, almost every representative builder of aircraft, engines, instruments, and equipment—including the United States Government—employs NORMA-HOFFMANN PRECISION BEARINGS to insure safety and long, uninterrupted service. * * * * Typical NORMA-HOFFMANN Aircraft Bearings are here illustrated. Write for the general Engineering Catalog which describes 108 distinct series embracing over 3000 sizes—a PRECISION BEARING for every load, speed and duty.

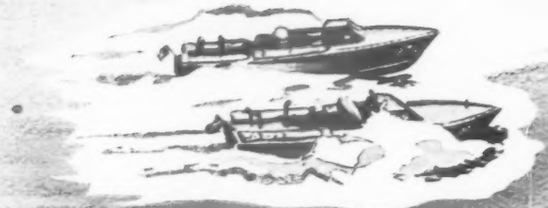
NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U.S.A.

PRECISION BALL, ROLLER AND THRUST BEARINGS

National's PART IN AMERICA'S WAR PROGRAM

In every branch of Uncle Sam's Armed Forces you will find National Quality Sand and Permanent Mold Aluminum Castings. Because of our long experience in making quality products, we were selected to produce castings for every branch of Uncle Sam's Armed Forces..A good thing to remember when normal times arrive.





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FOR SAND AND PERMANENT MOLD ALUMINUM CASTINGS

National CASTINGS ARE BEING WIDELY USED TO SPEED VICTORY

THE NATIONAL BRONZE AND ALUMINUM FOUNDRY CO.

Twin Plants, Cleveland, Ohio

NEW YORK, 111 Broadway
DETROIT, Stephenson Bldg.
CHICAGO, 188 W. Randolph
LOS ANGELES, 405 S. Hill

SIDE SLIPS

• WE HAPPENED to be present on a very sad occasion recently. Some men employed in clearing up the weeds in back of our old hangar came upon the fuselage skeleton of an old Curtis JN-4, affectionately known as "Jenny" to thousands of prominent individuals in the aviation industry today. The fuselage had been carefully set up on blocks by some unknown owner, who probably thought he was saving a valuable commodity against the days of his old age. It was very much like looking upon the wall scratchings of cave men or the ruins of an ancient temple, and, like the carpenter in "Alice in Wonderland" we shed a bitter tear.

Gentlemen, the facts might as well be faced: the useful life of our old friend has passed; the day of the Jenny is gone forever. A doubtful 60 miles per hour top speed can't compete with the 400 to 500 m.p.h. so blithely discussed by today's engineers, nor can a ceiling of from 4 feet to 4,000 feet, depending on

weather, compete with the 40,000 feet at which today's air battles are being fought.

However, it was a fearful and wonderful machine which had been devised by Glenn Curtiss and his crew of geniuses. Many of these geniuses came from the farms about Hammondsport, N. Y., and some of them are back on those same farms, happy and contented in the knowledge that they helped lay the cornerstone of modern aviation.

Drawings for the Jenny were made on white-washed factory walls, and design was accomplished by standing off and squinting at the longeron, beam, or strut involved. It is surprising how close they came to the exact structural sizes, and many a modern inventor is startled to find his idea anticipated by another inventor of 1914 vintage.

Flying a Jenny was a liberal education in itself. Never a dull moment. After an appropriate period of warming up, one "revved it up," and if satisfied with the tachometer reading, waved away the wheel chocks, gave her the gun, and started on adventure.

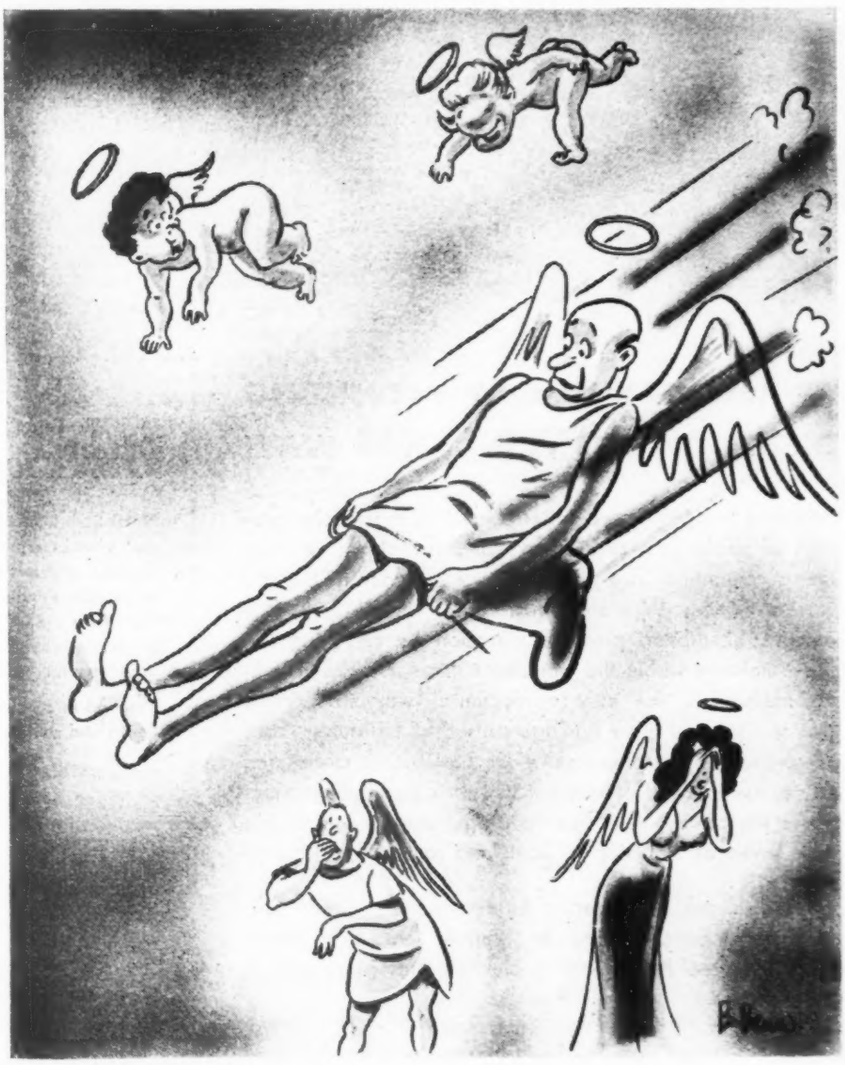
The experienced pilot aimed at the gap in the line of trees at the end of the field, for the climbing of a Jenny could never be predicted. If the day was not bumpy, nor hot; if the astrological reading of the stars was satisfactory and the tide was at flood, one got off and climbed. Otherwise one simply got off and stayed three or four feet off the ground until sundry obstacles interrupted the flight.

Outside of a tachometer, the instrument board was decorated only with holes which always aroused speculation as to what they had been intended for. They were convenient places for hanging gloves, hooking up the speaking tube for the student, stuffing a railroad map or two, and enabled one to put the chewing gum on the *back* of the board.

The engine was canted downward, presumably for stability; however one couldn't help but wonder what the stability characteristic had been before that. The rocker arms sprayed the occupants with grease and the crankcase oil came out in a hot flood if the top of the coop held the ship inverted for too long. Everything on the engine was exposed to the elements, and when a rain storm got at the magneto, the pilot selected the best spot available within two minutes of flying time.

The instructor rode in the "golden chair," indicating what happened to him when the Jenny spun in, whereas

(*Turn to page 206*)



"Maguire is trying to fly backward like those new tail-first jobs, but he can't keep his shirttails down!"

CUT ASSEMBLY TIME BY PREVENTING CORROSION THE PROTEK-SORB WAY!

Davison's Protek-Sorb Silica Gel has shown the producers of implements of modern warfare that time-wasting slushing compounds are not necessary in order to prevent corrosion during shipment or storage. Protek-Sorb, the protective absorbent, prevents corrosion by removing the cause—moisture within the shipping container. The Protek-Sorb method is the only fundamental way to prevent corrosion, rust and other damage caused by moisture. Parts, accessories and supplies arrive at destination clean and ready to use. Assembly lines quicken their pace—equipment flows to the battle lines in uninterrupted streams. Valuable time is saved at the shipping point and receiving point.

Any product can be protected by Protek-Sorb. Even now, engine parts, complete engines, finished tanks and planes are being given Protek-Sorb protection during storage or shipment.

It's time to discard slow methods that waste your time and your customers' time. Use the modern, positive corrosion preventative—Protek-Sorb! Give your customers a service they NEED!

HOW PROTEK-SORB PREVENTS MOISTURE DAMAGE

Protek-Sorb is a chemically inert, non-reactive granular material that absorbs more than 45% of its weight in water by a physical phenomena known as surface adsorption. Placed within the shipping container WITH the product it reduces and holds the relative humidity within the container to far below the danger point. Corrosion, rust, mildew, bacterial action cannot occur in its presence.

Supplied in convenient, ready-to-use cloth bags packed in air-tight metal containers.

TECHNICAL INFORMATION SENT ON REQUEST

Protek-Sorb

SILICA GEL

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THE DAVISON CHEMICAL CORP.

Industrial Sales Department

BALTIMORE • MARYLAND

Aviation's Long Tax Road

By SELIG ALTSCHUL

TAX NEWS will occupy the limelight during the months ahead. The Treasury Department's outline for a record-breaking tax bill is believed to represent the most severe proposal to be presented for consideration. Congress, from all indications, entertains more lenient ideas—relatively speaking, on taxation. Yet, there were a few heartening characteristics surrounding the Treasury's tax measure.

Completely abandoned was the insistence for calculating excess profits solely on the basis of a return on invested capital. Such a proviso could prove unduly harsh on aircraft companies, as indicated in AVIATION for November, 1941.

A plan for post-war rebates was also revealed. Refunds after the war would serve to cushion the shock of post-bellum economic shifts. This proposal would operate "in the case of any dollar of corporate profits, the receipt of which results in an increase in tax beyond perhaps 80 cents, the additional tax on such dollar shall be held by the government to the account of the corporation and be returnable within a limited period after the war, in those cases where it is spent for new and additional capital equipment or otherwise is spent in the additional employment of labor." This provision in the nature of a forced loan scheme, is similar to a plan now in operation in England. This recommendation is of vital significance to corporations in the top excess profits tax bracket as well as those faced with tremendous adjustments after the war. The aircraft builders are definitely in this category on both counts and will consequently follow this proposal with intense interest.

PROFIT LIMITS OPPOSED

The Treasury also expressed opposition to suggestions limiting profits on war contracts. Higher excess profits, the Treasury contended, are much more desirable and will recapture undue profits. This procedure may be found preferable in the aircraft industry as it may preclude additional time-consuming and involved reports to be filed.

In the Treasury proposal, the effective top bracket could be raised to 89 percent of corporate income as compared to a possible maximum of 72.4 percent at present. This new top rate, if enacted, could effect a wide majority of the aircraft companies.

It must be emphasized that this tax proposal is far more drastic than the final bill which Congress is expected to enact. As in the past, while the House Ways and Means Committee may originate new revenue measures, it is the Senate Finance Committee which will determine the major form of the tax bill. And the chairman of the Senate Committee is known for his firm opposition to levying an onerous confiscatory tax upon corporate profits.

In any event, whatever form the 1942 tax bill assumes, it appears a certainty that industrial earnings for the coming year will fall decidedly short of the 1941 level. In normal times such a prospect would represent a decided influence towards lower stock prices. However, capitalization of earning power—particularly of the aircraft units—is already markedly subnormal. Once speculative psychology changes, it is entirely possible for the market to advance in the face of declining earnings. This was the case in 1918 when the 1917 wartime profits were sharply cut. The aircraft group, however, has its own special factors to contend with—mainly the uncertainty of the future. In due time, the market may be expected to evaluate the aircraft industry's prospects through the inevitable adjustment prospects that are bound to come.

It is becoming increasingly evident that this eye to the future together with a lower level of profits and the need for working capital, all conspire to keep dividends small in relation to recent earnings. This is well illustrated by the Douglas Aircraft Company report. While showing net earnings of $30.29 per share for its fiscal year ended November 30, 1941, the company paid a dividend of only $5 per share for the period, pointing out that 1941 profits are regarded "as resources to meet, in the future, the obligations of uncertain hazards of war."

It is of interest to note that Douglas, in view of its fiscal year ending November 30, is always one year behind in feeling the effects of increasing imposts. In other words, results for the past fiscal year were subject to the 1940 tax measure whereas virtually all other aircraft companies, reporting on the calendar year basis, were subject to the 1941 tax law.

JUST BEFORE GOING TO PRESS, the Civil Aeronautics Board ordered reduced and retroactive mail compensation for American Airlines. This decision represented a bombshell as reflected by an instantaneous decline of 3¼ points in the already depressed American Airlines stock. This market action was nothing more than a barometer, the fundamental and underlying factors now present are more ominous.

Despite examiners' reports recommending retroactive and reduced mail pay for American and Eastern, many investors and other interested parties, refused to view these recommendations seriously and somehow were certain that the CAB would not order recapture of mail payments. The flouting of these reports is indicated, in one instance, by the substantial purchases of Eastern and American by important investment trusts, as revealed here last month.

Severe as rising taxes and other costs may be, it is the uncertainty of retaining previously reported earnings—injected by the CAB decision that remains the most important obstable to future air line progress. This will be treated more fully in a subsequent article.

Barron's Stock Averages

	Aircraft	Air Transport	50 Stocks
Mar. 6, 1942...	30.80	17.12	61
Feb. 27, 1942...	32.35	19.38	62
Feb. 20, 1942...	30.00	19.59	61
Feb. 13, 1942...	30.58	20.28	61
Feb. 6, 1942...	31.62	20.94	64
Mar. 7, 1941...	36.22	21.56	71

SURTAX WOULD HIT AIRLINES

While the airlines, under the proposed tax bill appear to maintain their exemption from paying excess profits taxes, they would be hard hit by the new surtax schedules. The present 31 percent top tax rate (24 percent normal and 7 percent surtax) would be replaced with the same normal tax rate and a special surtax of 16 percent on the first $25,000 of income and 31 percent on the balance. If enacted, this could make an effective tax rate of virtually 55 percent for many air carriers.

Here too, it must be pointed out that these new tax schedules may be of academic interest only if the tax measure submits to its expected revision. It is also recognized that airline earnings are not of the proportions to engage the envy of the tax collector. During the years 1940 and 1941, the domestic airlines average aggregate earnings of

(*Turn to page 228*)

Security Airster

In three minutes' time, one man can convert the 40 ft. wing span of this plane into a convenient width of 13 ft. 4 in.

AN ITEM of no small importance to operators, who must rent storage space or build their own hangars, is the folding wing arrangement on the Security Airster, built by the National Airplane & Motor Co., Los Angeles, Calif.

Powered by a Security S-5 125 hp. engine designed by W. B. Kinner, chief engineer of the company, the Airster is a two-place, side-by-side low wing model with dual controls. Top speed is 120 mph. at 1950 rpm., and stalling speed 35 mph., which would make the ship adaptable to small, rough landing fields. Service ceiling is 18,000 ft., with an absolute ceiling of 20,000 ft. Initial climbing rate is 5000 ft. in 5 min., 10,000 ft. in 13 min. and 20,000 ft. in 1 hr. 10 min. Range is 300 mi.

Fuselage construction is of welded chrome molybdenum steel tubing, as are the wing stubs formed integral with the fuselage, and all tail surfaces. A rigid girder effect has been secured in the wings by double bracing all internal drag members, and the positive locking mechanism for the patented folding arrangement is standard equipment. The Airster is also equipped with a swinging motor mount, permitting easy access to the rear of the engine for routine service operations. Good visibility can be had in all directions from the cockpit, the transparent, cupola-shaped enclosure of which slides backwards for entrance or exit. Landing gear is the hydraulic type with internal expanding brakes.

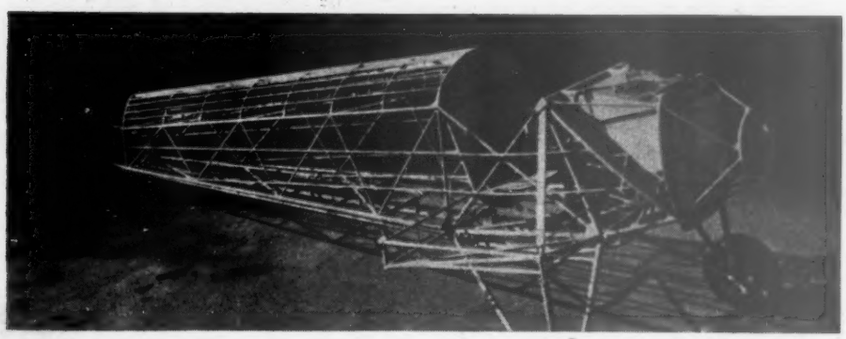
The Security S-5 engine is a 4-cycle, 5-cylinder radial weighing 325 lb. complete. Aluminum alloy cylinder heads are shrunk on the special alloy cylinders and held with four through bolts of high tensile steel. Cast aluminum rocker arm boxes are oil tight, with automatically lubricated rocker arms. To assure ample cooling, valves are set at a wide angle and are actuated by a single 3-lobe cam-drum, turning in crankshaft rotation and revolving concentric with the shaft. Hinge type cam followers relieve the tappet rods of all side thrust, which increases the life of the tappet rod bearings. A notable feature is the master rod construction. This is a steel backed, babbit lined bearing shell split on the vertical axis of the rod, and located with dowels.

The crankcase is an aluminum alloy casting built in three pieces. There are two anti-friction crankshaft bearings and one sleeve type, and a large thrust bearing is externally ribbed for better cooling. Dual Scintilla ignition with full automatic spark advance is provided. Current is supplied to the battery by a Champion generator, of the high output type, the charging rate being automatically regulated. Any direct cranking starter may be mounted.

Both the Security Airster and engine were manufactured by the American Aircraft Co., Long Beach, Calif., but all assets and manufacturing rights have been taken over by the National Airplane & Motor Co., present producers.

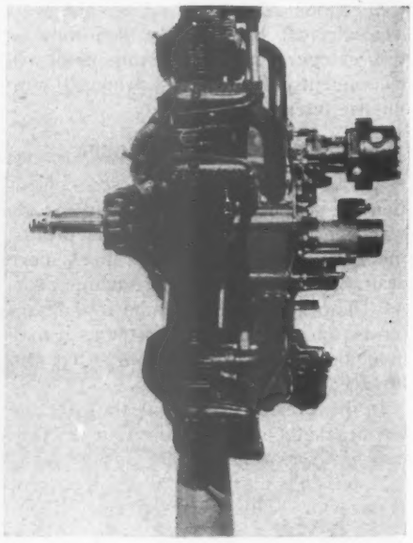
Specifications and performance data on the Airster are:

Span	40 ft.
Width with wings folded	13 ft. 4 in.
Length	23 ft. 11 in.
Height	8 ft. 6 in.
Wing area	240 sq. ft.
Gross weight	1900 lb.
Weight empty	1300 lb.
Useful load	600 lb.
Fuel capacity	23½ gal.
Oil capacity	3 gal.
Maximum speed	120 mph.
Cruising speed	100 mph.
Landing speed	35 mph.
Maximum ceiling	20,000 ft.
Service ceiling	18,000 ft.
Cruising range	300 mi.



The Airster fuselage construction is a welded chrome molybdenum steel tubing. Wing stubs are integral with the fuselage.

Designed by W. B. Kinner, the Security S-5 engine features ruggedness and long life.



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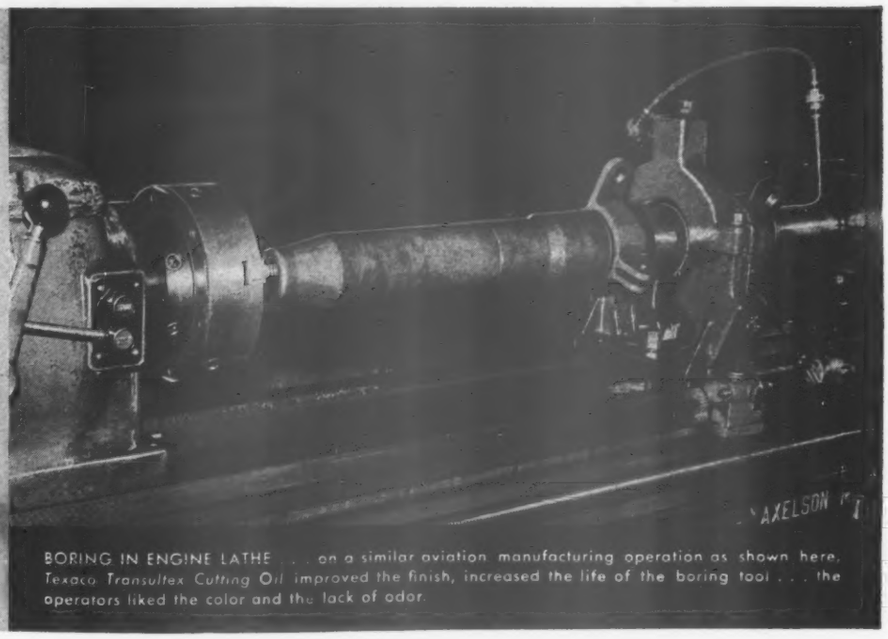

BORING IN ENGINE LATHE . . . on a similar aviation manufacturing operation as shown here, Texaco Transultex Cutting Oil improved the finish, increased the life of the boring tool . . . the operators liked the color and the lack of odor.

AVIATION manufacturers are "keeping 'em rolling" so that the boys can "keep 'em flying." Gigantic plants, machine shops, assembly lines . . . specialized machine-tools, high-speed, streamlined methods are in general use.

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TEXACO Cutting and Soluble Oils FOR THE AVIATION INDUSTRY

RETURN METAL DRUMS PROMPTLY . . . thus helping to make present supply meet industry's needs and releasing metal for War Needs.

Producing Maintenance Men

An aviation school trains maintenance and service men for the Air Forces and commercial services

By W. C. ERB
Registrar, Roosevelt Aviation School

Maintenance and service men may be called upon to do anything from cleaning a spark plug to rebuilding an airplane. The student is given thorough training in the use and working of metals in a completely equipped metal working shop. Here is a student operating a heavy duty nibbling machine. This is more than just an exercise, for the part he is working on will go into actual service.

FOR MANY YEARS, Roosevelt Aviation School has been one of the country's outstanding aviation pilot and mechanic schools. Taking stock of its facilities and capabilities for contributing to the nation's war effort, the directors of the school promptly arrived at some clear-cut decisions as to the utilization of its faculty and plant during the war period.

Recognizing the critical need for well-trained maintenance and service men for the Army, the privately operated military flying training schools, and for the commercial airline operation centers, the school determined to make an all-out effort to supply those needs efficiently and promptly.

Today, the entire facilities of the school are devoted to the turning out of maintenance and service men. The flying school is completely out of the picture.

Nearly one-half of the school's facilities have been turned over to the exclusive job of training enlisted Army men for maintenance and service duties in the military operational bases. The course is conducted by the regular

This is the advanced fuselage repair shop where certificated airplanes that have been damaged are overhauled and repaired for return to service. In many respects, the production line system is simulated, the airframes moving toward the back of the shop as the various stages of repair are completed.

This is the advanced wing repair department. A damaged wing from a Stinson RS 6 is being dismantled preparatory to rebuilding. All work is done under the supervision of qualified instructors and government inspectors. There is no time limit set for the completion of this work, the only objective being quality of work and thoroughness of instruction.

A section of the elementary engine department where students receive instruction and practice to prepare them for the advanced engine overhaul division. In the advanced division, the student works on engines of all types in actual service. In the Army division of the school, the latest types of military power plants are worked on by the trainees.

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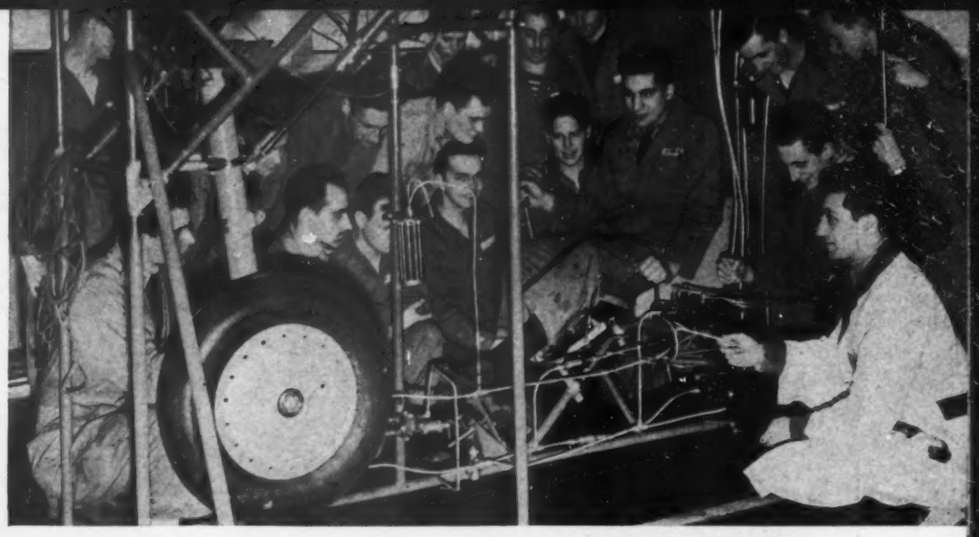
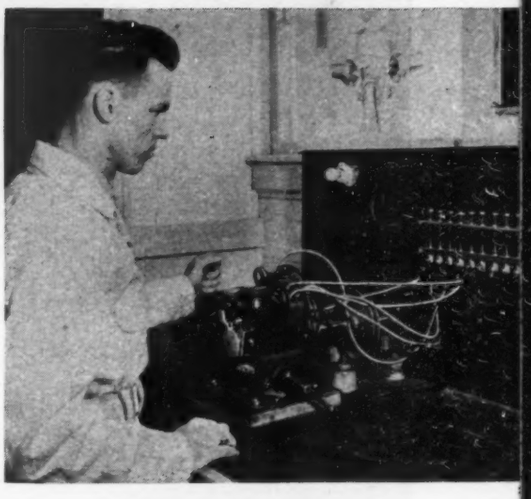
The 200 ton H-P-M Fastraverse triple-action p... shown above is drawing oil tank collars for t... Douglas C-47 troop transport, from .051"—3S0 st... —production 125 per hour. Other parts are typi... of the variety of work made on this press in t... Douglas plant, largest piece be... 23 5/8" long, 16 1/2" wide, dr... 2 9/16" deep.



A group of Army students in the hydraulics laboratory. The apparatus shown in the picture is a hydraulic "mockup" developed at the school to demonstrate the operation of an airplane's hydraulically operated landing gear, brakes, and flaps.

An Army trainee is learning how to test generators on an Allen testing machine. The generator was repaired and rebuilt by the students.



This is a test unit in the advanced engine department for the testing of overhauled and rebuilt magnetos. Performance at various speeds is observed with the aid of the tachometer mounted on the panel.

faculty according to Army requirements. Upon completion of the course, the men are ready to take their stations at repair depots throughout the country and on the far-flung fighting fronts.

This conversion has not been made to the detriment of thorough and complete training of maintenance men to meet the exacting requirements of the commercial airlines and flying schools. A more efficient allocation of facilities and the addition of more equipment, where necessary, has insured the continuance of the pre-war thoroughness of instruction. In fact, the course has been extended in scope to more adequately train the student to meet the increasingly difficult task of maintaining military training and commercial aircraft under the press of wartime conditions.

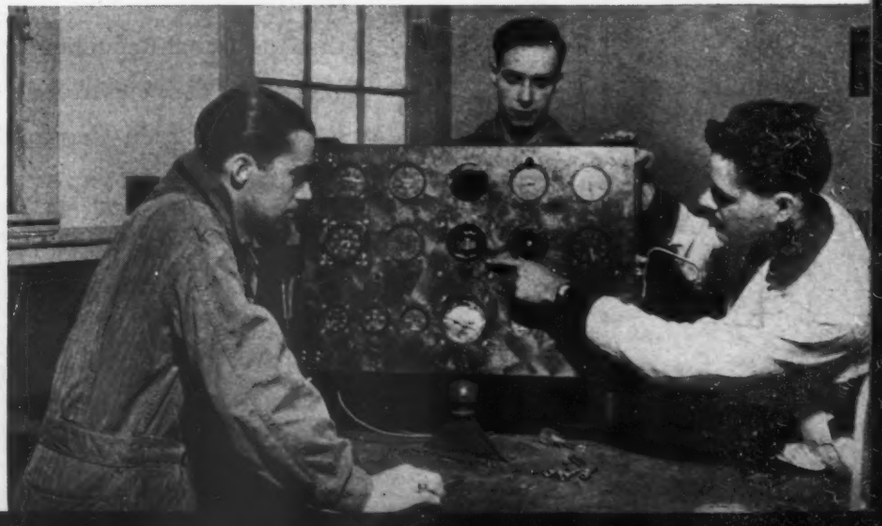
Prior to the outbreak of war, the principal "field experience" provided the students was the actual servicing of outside aircraft on a regular commercial basis. The only charge made for this work to the owner was for materials. Under this arrangement, there was no stipulation as to time for completion of the work, thus giving the students ample time to do the job thoroughly and well under instructional supervision. Since the war, many private airplane owners.

(Turn to page 223)

An instructor is explaining the construction and operation of a hydromatic propeller to future Army maintenance and service men.

Here an Army student is receiving instruction in the carburetor laboratory where carburetors are dismantled, over-hauled, and tested Note the section of a supercharger assembly in the background

Twomore Army student are receiving instruction on the construction, repair and operation of instruments in the instrument laboratory of the Army maintenance and service school.

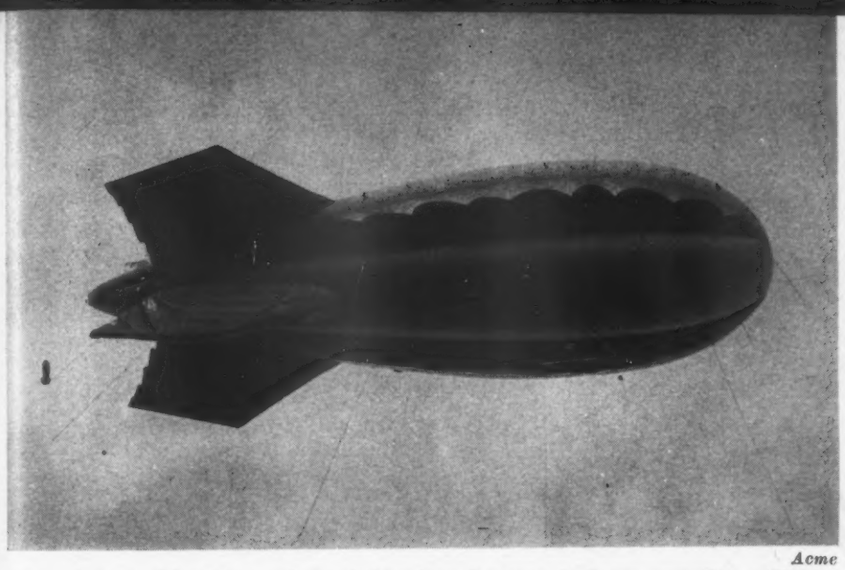


"ATTACK DIVE" by John Hammer

A SAFE 680 M.P.H. . . . It takes exceptional engineering to build an airplane that is safe in a 680 m.p.h. dive. Thrusting downward at this prodigious speed—or outclimbing, outflying, outgunning all contemporaries—the sensational Republic *P-47* THUNDERBOLT is the tangible expression of the high engineering skill which planned it to the last detail. Republic Aviation Corporation, Farmingdale, Long Island, N. Y.

REPUBLIC AVIATION

REPUBLIC AVIATION



Acme

One of a considerable number of American barrage balloons guarding military objectives in the Pacific Northwest. These balloons are under Coast Artillery Command.

Barrage Balloons Over Land And Sea

By J. I. WADDINGTON
M.A., A.F.R., A.S.

As Americans now look seriously to defense against air attack, British experience becomes of more than academic interest. This article outlines the function and success of the barrage balloon as an integral part of the aerial defense system.

IN THEORY and in general practice, aerial defense in Britain is divided into layers or zones of defined altitudes. The highest zone is defined as that above effective anti-aircraft gunfire; the next lowest is contained by the range of anti-aircraft, but this zone has a lower limit beneath which it is difficult or impossible for guns to operate, either because of danger or damage to local property, or because of inaccuracy of fire against aircraft moving rapidly at low altitude. This lower limit is established at around 5,000 feet. It is the function of the balloon barrage to cover the area of the defended position up to that height.

AUTO WINCHES USED

The gas bags themselves are designed to carry a cable sufficiently strong, and therefore heavy, to be destructive to the enemy aircraft on impact. The present British standard type of balloon has a capacity of 20,000 cu. ft. and is inflated with hydrogen. High altitude types of much larger capacities have been tried —the French flew balloons up to 20,000 ft.—but the weight and strength of the cable had to be reduced until it did not possess the necessary destructive power.

The ground equipment for the balloons is carefully designed to provide standardization, using components easily obtained, robustness and ease of operation by unskilled crews. The truck which carries the winch is a standard heavy Ford chassis with a Ford V8 motor mounted on it to operate the winch, and which is controlled exactly the same way as a car—foot clutch, brake, etc.

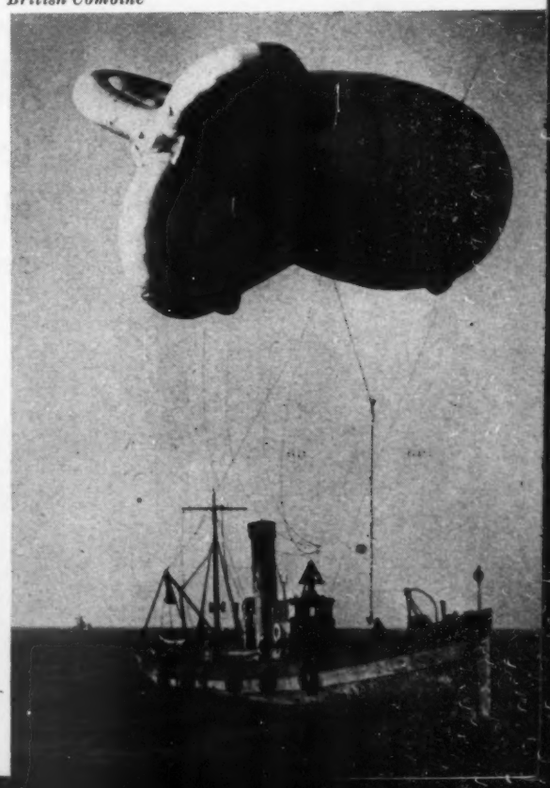
BALLOON SPACING

The balloon barrage is operated and maintained by a separate R.A.F. Group, but the tactical operation is controlled by Fighter Command, which dictates when the balloons must fly and when they must descend. For any defended area the optimum spacing of balloon sites is that which provides a compromise between the risk of fouling the cables and the closest spacing required to prevent enemy aircraft flying through gaps left in the barrage. During the

(*Turn to page 214*)

Military

British Combine



At right: A unit of London's river balloon barrage system. These units are now issued properly fitted-up barges containing living quarters for the crew . . . Below: The "bumper" fitted on the wings of this wrecked German Heinkel is designed to cut the cables of barrage balloons defending British cities. There has been no report on the success of these devices, but the added weight reduces the plane's speed and bomb load capacity.

Wide World

Announces

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and unloading of parts and sub-assembly shipments. It minimizes, and practically eliminates any possibility of damage during shipment—and permits a maximum load to be handled in minimum space, with much reduced dunnage.

We cannot publish photographs or details of the savings that are being made with this new development, due to the censorship restrictions prevailing during the war emergency.

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Airliner Air Conditioning

A solution to the problem of maintaining constant temperatures in transport planes during lay-over periods.

By J. A. FERRIS *Publicity Director, Northwest Airlines Inc.*

MAINTAINING correct temperature within the plane while on the ground between arrival and departure times is a problem that has been successfully tackled by Vernon Lundquist of Northwest Airlines.

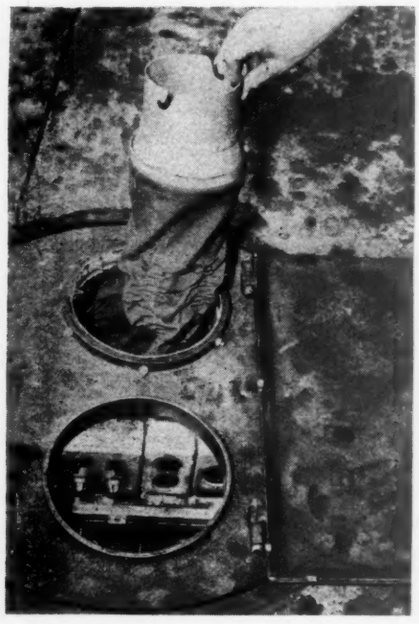
Because of weight limitations, it is impossible to have more than a moderate amount of insulation in transport planes. Consequently they absorb a lot of heat in the summer and cool quickly in the winter while on the loading ramp. For passenger comfort, it became necessary to have some sort of arrangement to provide conditioned air within the plane to keep the temperature constant.

To meet this problem, the first of a new type of air conditioning installation was made at the Minneapolis terminal of Northwest Airlines. In the basement of the Administration Building is a complete air conditioning unit supplying filtered warm or cold air to the planes on the ramp through an underground duct system terminating at manholes at the assigned position of incoming planes. The conditioned air is conducted to the plane interior through a flexible air hose drawn from the manhole. Control switches and utility electric outlets are located conveniently at the manhole.

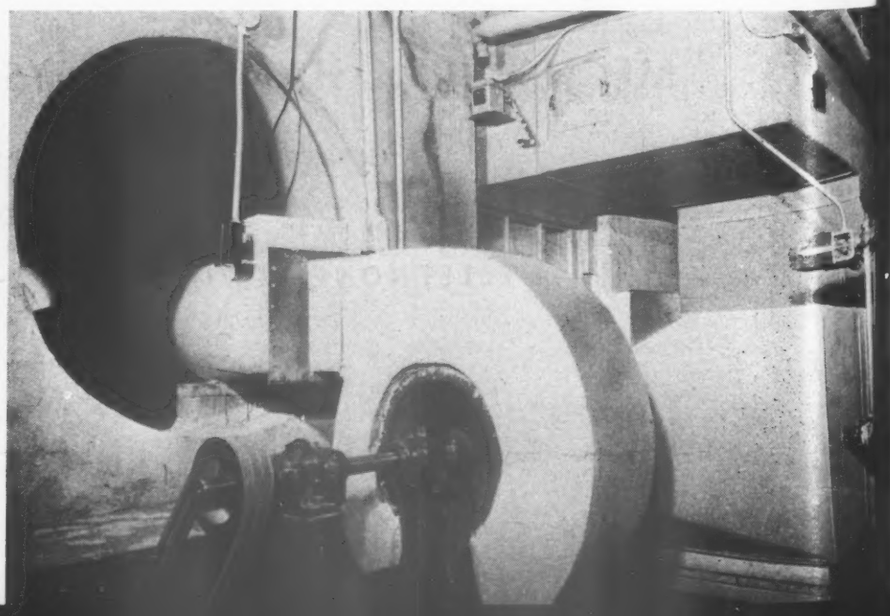
In operation, fresh air is drawn through an automatically opening intake duct and passed through a set of spun glass filters to remove dust and impurities. The air is then passed over heating or cooling coils after which it is forced by a fan through a main duct leading to the distribution system.

During the summer, the cooling coil is supplied with a refrigerant (Freon) which lowers the air temperature to 55 deg. F. In the winter, two steam coils are used to heat the air to approximately 140 deg. Steam is supplied through electrically controlled automatic steam valves which open and close as the fan starts and stops.

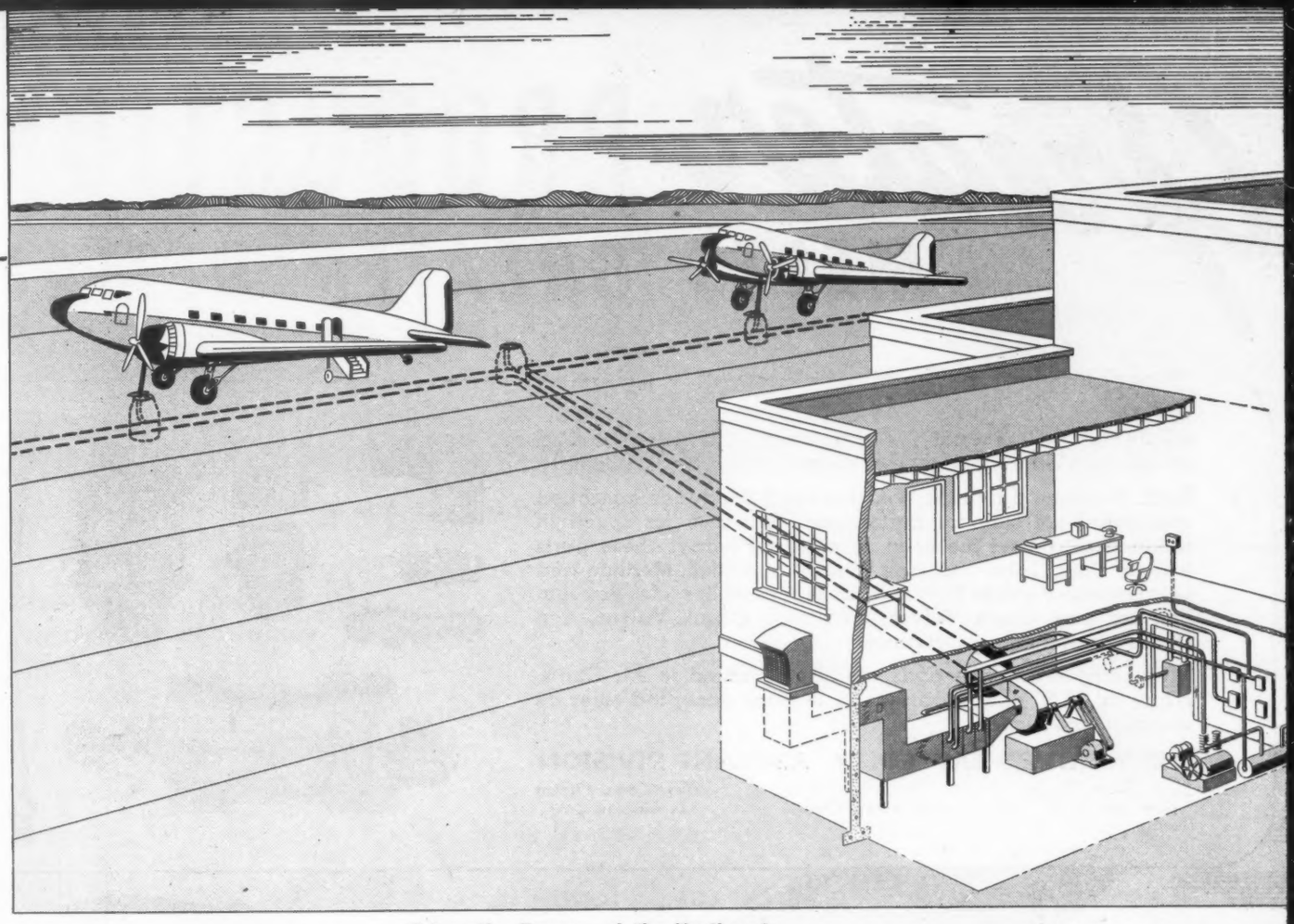
The 18 in. transmission duct extends



When not in use, the air hose is retracted into the manhole which is covered flush with the apron surface. Note the location of the control switches and utility electric outlets.



The air conditioning unit in the basement of the Administrative Building. After being cleansed and heated or cooled, the air is blown through the main duct leading to the distribution ducts under the loading ramp.



Schematic diagram of the Northwest Airlines air conditioning system designed to maintain constant temperatures in the planes during lay over periods.

underground from the air conditioning unit to the 12-in. distribution ducts which branch off at approximately right angles under the loading ramp for a distance of 225 ft. in either direction. At 150-ft. intervals along the duct a vertical duct carries the air to the manhole outlet at the apron surface.

This installation is an important contribution to the comfort of NWA passengers particularly in the instances of 15 min. layovers when the passengers may prefer to remain in their seats.

Military authorities, too, have shown considerable interest in the installation. The maintaining of uniform temperatures in grounded aircraft is important where contraction or expansion of vital metal parts may seriously damage or impair the efficiency of precision armament fixtures.

For those who have a more detailed interest in the installation, there follows a list of the equipment included in the air conditioning unit.

AIR CONDITIONING UNIT EQUIPMENT

Fifteen ton capacity Freon condensing unit consisting of a four cylinder compressor and a 15 hp., 220 volt, 60 cycle, 3 phase motor.

Fifteen ton shell and tube condenser.

Air conditioning cabinet in which are contained the following:

Motor operated inlet air damper

A flexible air hose is drawn from a manhole on the ramp and connected to the duct system in the plane. A direct connection is thus established with the air conditioning unit in the basement of the Administrative Building.

Set of six throw-away type dust filters

Six-row direct expansion coil with a face area of 21x41 in. having a thermal expansion valve and heat exchanger

Single row tempering steam coil having a face area of 6.2 sq. ft.

Double row steam heating coil having a face area of 6.2 sq. ft.

Mill exhauster type fan delivering approximately 2,500 to 3,000 cfm of air at from 6 to 8 in. H_2O static pressure.

Fan motor—7½ hp., 220 volt, 60 cycle, 3 phase, driving fan by "V" belt drive.

Set of controls consisting of the following:

Performance Specifications

Heating Cycle

Inlet air temperature to conditioner (min.)	20 deg. F.
Temperature of air at fan discharge	140 deg. F.
Temperature of air at hose outlet	125 deg. F.
Btu per hour	350,000
Cubic feet per minute	2,500 to 3,000 at 6 to 8 in. H_2O

Cooling Cycle

Inlet air temperature (max.) (D.B.)	100 deg. F.
(W.B.)	75 deg. F.
Temperature of air at fan discharge	55 deg. F.
Temperature of air at hose outlet	65 deg. F.
Btu per hour	200,000
Cubic feet per minute	2,500 to 3,000 at 6 to 8 in. H_2O

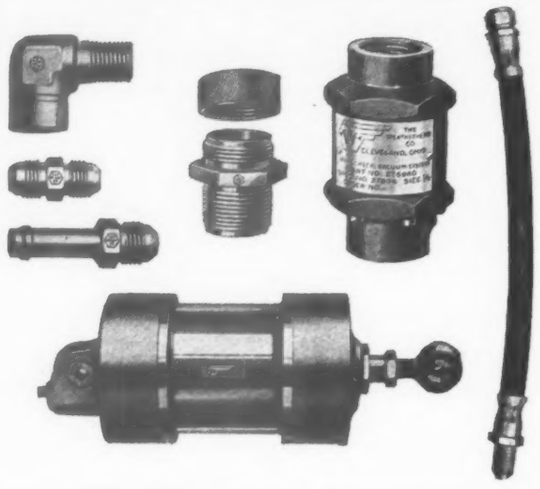
(*Turn to page 223*)

Greater PRODUCTION MEETS GREATER DEMAND

• With "all-out" for victory, Weatherhead is answering the need of the hour with dependable aircraft accessory equipment.

Each airplane part that Weatherhead produces has been engineered not only for performance but also for speed in production to meet the need so essential today. These parts include Dural Tube and Pipe Fittings, and High, Medium and Low Pressure Flexible Hydraulic Hose Assemblies; also Vacuum Selector and Check Valves; Hydraulic Check Valves; and Hydraulic Actuating Cylinders.

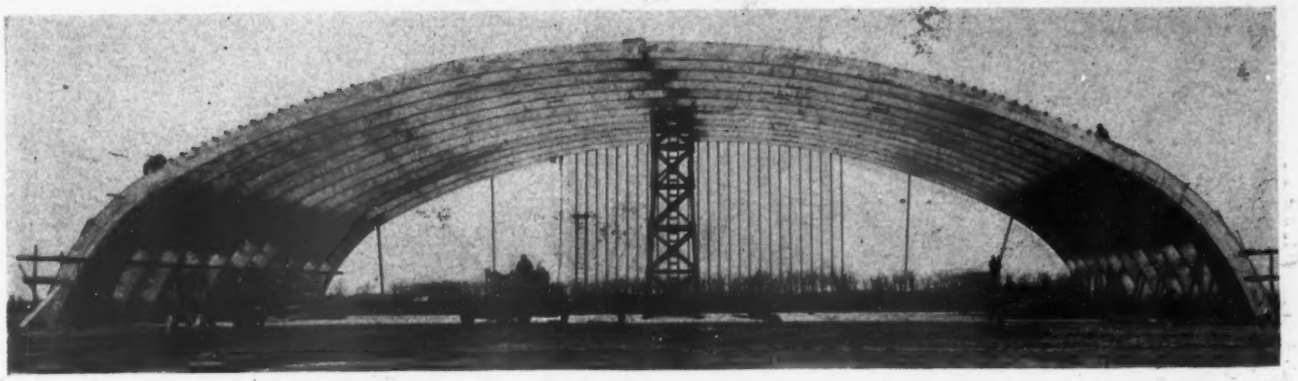
Weatherhead airplane parts are manufactured to Air Corps, Navy or "AN" specifications in regular accepted sizes as standard production.



THE WEATHERHEAD CO. • AIRPLANE DIVISION

East Coast Office	*Main Office*	*West Coast Office*
New York, N. Y.	Cleveland, Ohio	Los Angeles, Calif.

WEATHERHEAD



Laminated wood trusses of the Northwest Airlines hangar at Fargo, N. D.

Wood Frame Hangar For Northwest Airlines

Thirteen wood arches, each 152 ft. long, form the frame of the new Northwest Airlines hangar at Fargo, N. D. Constructed to accommodate the giant Douglas DC-4, the hangar will have a maximum height of 35 ft. in the center. Ten-foot spacing between the arches gives the hangar a depth of 120 ft., which may be easily extended whenever necessary.

The arches were designed and fabricated by Unit Structures, Inc. in Wisconsin. They are three-hinged arches, glued up a half arch at a time. Twelve of the 13 arches have a cross section of $7\frac{1}{2}$ in. wide by $27\frac{5}{8}$ in. deep, built up of $\frac{3}{4}$ laminae, each $\frac{13}{16}$x$7\frac{1}{2}$ in. The thirteenth is made in $7\frac{1}{2}$x$7\frac{1}{2}$-in. cross-section to serve as a combination of form and plate for the end wall opposite the door.

The completed half-arches were shipped on two flat cars with a 40-ft. idler car between to take up the overhang.

Although inexperienced with arches of such size, the local contractor had no difficulty in making the installation. Concrete abutments were prepared at the site. These included full-sized abutments at the rear so that a $7\frac{1}{2}$x$27\frac{5}{8}$-in. arch can be substituted readily for the $7\frac{1}{2}$x$7\frac{1}{2}$ in. arch, if the hangar is ever enlarged.

The base of the arch is fitted into a metal shoe fastened on top of each abutment, and held in place by a long bolt. Let into pre-cut daps in the wood, metal Tesco shear plates, 4 in. in diameter, spread the load from the relatively small bearing area of the bolt itself over nearly the entire cross-section of the wood. At the crown, where the half-arches join, a hinge effect was desired rather than rigidity, and plain bolts were used.

Dressed and matched, 2x6-in. siding was nailed directly to the arches, which form both the sides and the roof. No joists were needed for the roof.

The Fargo hangar was built under the supervision of Karl O. Larson, chief engineer of Northwest Airlines, who decided on the strength, efficiency, availability, and economy offered by wood construction.

Air Transport

Britain's Auxiliary Air Bases

By EMIL K. HARVEY

The wisdom of the old adage of not putting all your eggs in one basket is being practiced in good faith by the British. Two and a half years have taught them the value of diversified operations which has resulted in airports scattered all over the landscape of the British Isles.

Cleverly camouflaged, these bases are hard to detect from the higher altitudes at which enemy planes are forced to fly. Many a meadow has been converted into an auxiliary air station, but the modern art of protective obscurement fools the observer aloft into believing that he is still seeing a meadow. The proximity of fields is dictated primarily by the safety considerations, after the value of the land for farming purposes has been weighed.

Contrary to the thought of military bases with elaborate administrative headquarters and large hangars, these outlying airports rank in simplicity and obscurity. Long paved runways now replace the fine naturally drained turf of which Britain has always boasted. Heavy loads and high speeds, reliability and control necessitated the change. The pavements are either asphalt or concrete, depending upon the judgment and equipment of the local contractor. The surface of the pavement is treated to match in texture the immediately adjacent land which may vary a number of times the length of the runway. Painted in deep greens, browns and blues to blend with the surrounding scenery, it is almost impossible to identify their existence.

Skirting the edge of the field well hidden among trees and brush, are what might be called hangars. These consist only of sand bags piled up on three sides the height of the planes and large enough to shield two ships. Five or six units are distributed well around the field which limits the number of aircraft stationed at one location.

The airfield design is made complete by connecting the ends of the runways to the protected stations by taxi-strips which virtually circumscribe the landing area with a road. This design assures quick unhampered movement of aircraft between the landing area and storage units. The sand bag hangars provide sufficient space and equipment to check planes and make minor repairs.

Ground traffic regulations are simple, but concise. Individually, the planes taxi to the end of the runway and takoff. On coming in, the operations are reversed. After the plane lands it continues along the runway to the end where it turns off on the taxi-strip and heads for its designated hangar and thus concealment. Simplified ground movements together with hidden segregated hangar units minimizes the possibility of pursuing craft from sighting the base. In the event of an attack damage would be localized due to the segregation of the protected units and type of construction. Obviously these auxiliary fields are limited in number both by the efficiency of their proximity and land available. They are however, an answer in part to military flying and protective concealment under war conditions.

U.S. ARMY
above all else
One purpose stands above all else at BEECHCRAFT. We are determined to exceed all War production demands now and hereafter made upon us by our Nation.
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BEECH AIRPORT WICHITA, KANSAS, U.S.A.
PICTURED IN FLIGHT: U.S. AIR CORPS TYPE AT-7 BEECHCRAFT NAVIGATION TRAINER

By W. W. MACDONALD

Control Tower Operations Recorded On 24-Hour Basis

Equipment installed in the control tower at San Francisco airport by Frank Rieber, Inc., permits recording of all incoming and outgoing radio messages with a minimum of attention on the part of the operator, constituting a permanent 24-hr. log. This at present involves handling a simplex, or one-channel-at-a-time, communication system incorporating six receivers and a single transmitter. Provision has been made for recording seven additional channels, should this ever prove necessary.

The installation consists of two constant-groove-speed instantaneous recorder-playback units, functioning consecutively to avoid omissions which would inevitably occur were it necessary to cease recording while changing a disk. The turntables of these units, normally still, are rotated when transmitted or received signals actuate sensitive electronic relays and automatically turn power on. A "squelch" circuit, associated with the relays and functioning when there is no incoming or outgoing traffic, prevents operation of the equipment by static bursts.

Where continuous automatic recording is not required a time-clock mechanism may be switched in to turn the machines on and off at pre-determined times, in which case there is a two minute overlap or duplication in the event that the changeover from one turntable to the other occurs in the middle of a message. The machines may also be operated manually, or connected to record outgoing messages only. A particularly useful feature is provision for playing back indistinctly heard portions of received messages while the machines continue to record the remainder.

Plastic disks used are 12 in. in diameter and record 62 min. of sound on each side, this long playing time coupled with intermittent use reducing the number of disks which must be handled in a day to a minimum. Each disk is equipped with a label upon which the operator may record the date, time and other pertinent data required by the FCC. Disks are stored 40 to the inch in an ordinary filing cabinet.

B. M. Doolin, manager of San Francisco's airport department, manipulates tower communication controls. New automatic recording and playback equipment appears at the left

Light Weight Transmitter-Receiver

Following extensive tests in military service, Bendix Aviation, Ltd., of North Hollywood, California, has announced a 25 lb. aircraft radio system, claiming performance comparable with many heavier sets.

Known as Model 3801, the system comprises two separate units connected together by means of a cable. One unit contains the transmitter and the receiver and may be installed in any readily accessible location. The other contains the powerpack and may be located anywhere in the aircraft.

The receiver is a six-tube superhetrodyne with a stage of tuned radio frequency amplification. Two frequency bands are provided, one for the beacon channels and the other for communication with the ground and other aircraft. One tuning control and a volume control are on its panel.

Jack boxes located at both units provide handy connections for microphones, headphones and telegraph keys. A built-in antenna relay permits the use of a single antenna for both reception and transmission.

Battle-Proof Parts

Manufacturers of aviation radio parts, now fully aware of the fact that components going into ships intended for military use must withstand the shock of gunfire, are re-designed to meet this new and severe requirement. One good example of the current trend is found in rheostats made by the International Resistance Company of Philadelphia. Bakelite instead of ceramic insulation is used. Another example is seen in the design of CS series sensitive d.c. relays made by the General Controls Company of Glendale, California. These relays are mounted within molded phenolic enclosures with removable transparent windows, are adjusted by varying their armature gaps rather than contact spacing.

OFFICIAL PHOTOGRAPH U. S. NAVY

PROVED IN ACTION

"... During the recent engagement with enemy submarines, successful attacks were made by Kingfisher OS2U type, against submarines."—*Rear Admiral J. H. Towers, Chief, U. S. Navy Bureau of Aeronautics.* Hundreds of these Vought-Sikorsky Observation Scouts have joined the battle fleets of the Navy. Hundreds more are on the way.

VOUGHT-SIKORSKY AIRCRAFT

STRATFORD, CONNECTICUT

ONE OF THE THREE DIVISIONS OF UNITED AIRCRAFT CORPORATION

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington C. F. McREYNOLDS, Pacific Coast RANDOLPH HAWTHORNE, New York C. B. F. MACAULEY, New York

Army Trimmed to Air, Ground and Supply—Single Command for AAF; Air Corps Out; All Sub-Commands Report to Gen. Arnold

Washington (AVIATION Bureau)—Preparing to take the aggressive against the enemy as soon as rising armament production has reached the desired level, Commander in Chief Roosevelt has drastically reorganized the Army for modern action.

All branches like artillery, cavalry, infantry, are shorn away and the Army now has only three commands: Air Force, Ground Force, and Service of Supply. Notice that Air Force is named first.

The Air Force too is streamlined under a single command, with the Air Corps and the Combat Command abolished. Lieut. Gen. Henry H. Arnold, formerly Deputy Chief of Staff for Air, is Commander of all the Air Forces. Reporting directly to General Arnold, are several commands, like the Army Flying Training Command, Ferry Command, Air Services, the four Combat Commands, etc. Organization was not complete at this writing; commands will be combined, new ones added.

Of course the Air Force and the Ground Force are under the single command of the President and the General Staff, which is headed by Gen. George Marshall. This reorganization ends for now all possibilities of the "separate" air force. It is pointed out that Britain's RAF is the only really separate air command in the world.

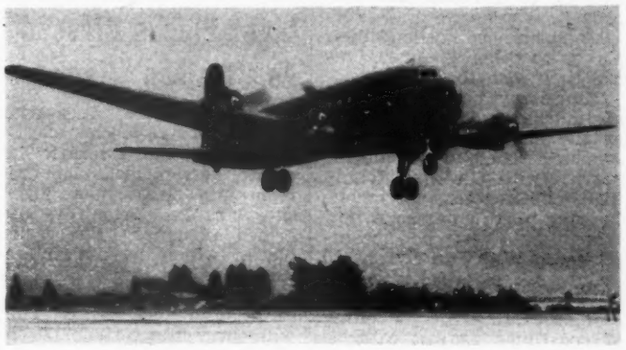
Basic aim in the new setup, which is patterned closely after the German system, is to unify command and to separate from the fighting forces any worry about development, procurement, and maintenance of supplies and equipment. The Service of Supply does that.

Since the Air Corps, which supplied the Air Force, is abolished, AAF has a procurement division, but it is assumed by responsible officers that procurement, including research and development of all aircraft will go to the supply branch of the Army. This is a shakeup clear down to the foundation, and some heads are still swimming.

Command of the Ground Force goes to Lieut. Gen. Leslie J. McNair, formerly Chief of Staff of General Headquarters, and Maj. Gen. Brehon B. Somervell, formerly Chief of Staff in Charge of Supply is in command of the Supply Branch.

The President authorized Secretary of War Stimson to set up, as he finds necessary, such other departments as overseas departments, task forces, base commands, defense commands, and commands in theaters of operations.

Lieut. Gen. Delos Emmons, formerly Chief of the Combat Command, is now in command of the Hawaii corps area, and Maj. Gen. George H. Brett is now deputy commander in the Far East.



Three Lions

Army version of the Douglas DC-4 transport takes off on maiden flight at Santa Monica, Calif. Designed originally as a luxury airliner, it has been modified to carry troops and equipment on fast missions and is now in quantity production.

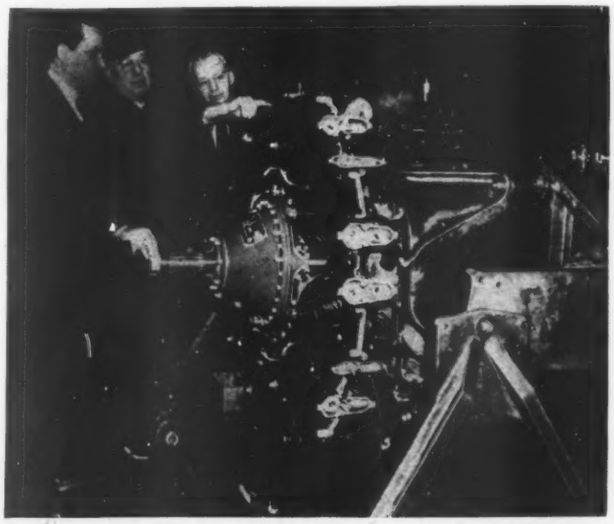
DC-4 In The Army Now

Airborne troops and supplies, heretofore almost exclusively an Axis monopoly, at least in the war news dispatches, will soon become an Allied Nations communique term, when the new, huge Douglas C-54's, now in mass production, go into service. Judging by production photographs just released, that day is not far distant.

Originally planned as an airline luxury ship, and listed as the DC-4, the huge transport was taken over by the U. S. Army Air Corps, changed in several respects to increase its performance, and is beginning to come off the Douglas assembly lines in increasing numbers.

It is equipped with a tricycle landing gear of the retractable type, with paired main wheels and a tricycle nose wheel, that give added braking power for short landings. It is powered with four 1350 hp. Pratt and Whitney Twin-Wasps.

As altered by the Army it will carry a greater load, faster, higher and farther, and that's all they'll say about it.



Wide World

Col. Antonio Guedes Muniz, aeronautical engineer and official representative of the Brazilian Government, left, inspects a Wright engine similar to the type to be manufactured in Brazil under a licensing agreement. M. F. Gemme, assembly superintendent of Wright, explains features of the engine. Alvin Sunday, manager of the company's license division, looks on.

CAP Formation Rule

Formation flying by Civil Air Patrol is discouraged until National Headquarters issues instructions. Those already doing so are on their own responsibility. Wide intervals of 500 ft. should be maintained until proper training directives on formation flying are issued. Members are also requested not to discuss their flights, what they saw or to send radio or phone messages about our forces.

Squadrons are beginning to build up their auxiliary workers, calling for mechanics, radio men, photographers,

guards, men and women with autos, and stenographers.

The women are conversing over whether their uniform shall be slacks or culottes. One 99'er says no matter how well tailored slacks are, most women look horrible in them. The official ladies' uniform will be culottes for street wear, but a squadron may select its own flying uniform subject to headquarters approval.

Members need not lend their planes to other members unless they wish to.

The Army has ordered all air markers within 150 miles of the east and west coasts screened. CAP units can cooperate with CAA by making flight checks to assure screening, and make notes as to how this might best be accomplished. With nearly 30,000 members, the Patrol is scheduled to assume defense duties soon, including the patrolling of coastlines against attacks.

CAP Gets Insurance

A blanket insurance policy at a low rate will protect Civil Air Patrol members against liabilities from accidents on Patrol missions or on training duty. Highest safety standards will be maintained but some protection is needed. Army, Navy, CPTP, and other air agencies require liability and property damage insurance. Otherwise, claims would be long in settlement under slow public procedures and a single accident might involve several members in expensive litigation.

The policy, written jointly by several underwriters, will cover public liability up to $50,000 per person injured, or $100,000 for one accident. Liability to passengers will be covered within the same limits, plus property damage up to $50,000. The underwriters are putting costs at a minimum.

A blanket policy is to be written for the whole CAP. The pilot on payment of his premium will receive an identification card which he can carry with his license and CAP credentials. The policy gives protection to the pilot, plane owner and any CAP officers and members who might have contingent liabilities. The insurance will be available through local insurance agents.

Safety rules governing CAP operations orders will be more restrictive than the Civil Air Regulations. More flying time will be required as a qualification for pilots to carry passengers on CAP missions.

The Los Angeles County Squadron has been preparing a number of parachute packs of food, medicine, and signal material for use in disaster relief. In Seattle, a CAP doctor is ready to land or parachute on the scene of airplane crashes, with folding operating table and surgical instruments. And in Miami a seaplane unit is being formed. Pilots at the Embry-Riddle seaplane base are enlisting in the Patrol and have 12 seaplanes available.

Light Planes Classed As "Liaison" Types

Several series of observation airplanes have been redesignated as liaison aircraft. The term "liaison" will be used from now on to mean light, short range, generally unarmed airplanes. Observation planes which have been redesignated as liaison include the O-49 series, O-57, O-58 series, and O-59 series. They will carry the letter "L" instead of "O."

The L-49 series are short-range, two-place Stinson monoplanes, equipped with radio, flaps, wing slots, steerable tail wheel and powered with a single 280 hp. engine. The L-57 is the Taylorcraft highwing monoplane, with two seats in tandem. It carries radio but no armament. The L-58 is Aeronca, and the L-59 is Piper.

Nearly all of the light plane contingent will be in the Ground Force and some in the Service of Supply. A few will be assigned to Air Force.

PAA Sends Six Students To South America

Six more college students from the United States have been selected by Pan American Airways to study in South America during 1942 under its travel fellowships instituted in cooperation with the Institute of International Education in New York, in 1937, to promote inter-American relations.

Air transportation is provided by the airline in conjunction with a scholarship for maintenance and tuition given by a United States college or university. Under this plan Pan American Airways in the last four years has brought 46 Latin American students to this country, 13 of whom were awarded travel fellowships last fall for the academic year of 1941–42.

Private Flying Is On War Probation

Strict CAA rules putting a ban on flying except at designated airports with continual guard, works hardships on unscheduled flights, in the opinion of National Aeronautics Association. Civil aviation still is on trial as to its ability to carry through the emergency without risk of subversive use of planes, says NAA. The regulations will remain drastic until flyers are more organized and experienced in flying under wartime conditions.

Special permission may be granted for planes to be kept at private fields other than designated airports, provided ships are dismantled when not in use. Flights can be made on clearance from the nearest designated airport. Provision is made also for crop dusting, trapping and other activities which require aerial operations. The purpose of the regulations is to "Keep 'Em Flying."

Lady Cop for Ryan

Ryan Aeronautical Co., San Diego, Calif., has employed, it is believed, the first woman "cop" to guard a defense plant in the southern California area. She is Mrs. Helen Goodrich, an expert pistol shot and widow of a motorcycle policeman killed in a traffic accident. She will be on duty at the Ryan training plane factory in departments where women are employed.

CPTP Funds Upped

Except for some small reduction, appropriations for CAA and CAB in the fiscal 1943 Commerce Department Appropriation Bill contain but one substantial change from this year's figures. This item is for CPTP which is raised to $36,000,000, from the $15,930,081 approved by the budget bureau. The bill provides that

Wide World

Group of "good neighbors" comprising 72 Brazilian and six Argentine youths pictured on arrival last month to participate in aviation training program for Latin-American students sponsored by CAA, the Army and other government agencies.

Harris & Ewing

Bacon and eggs, toast and coffee are prepared aloft by a member of the crew on long patrol flights. Good hot "chow" on long missions makes for greater fighting efficiency.

$8,000,000 of the total shall be used immediately to speed the program.

More than 70,000 pilots have been trained to date, of which more than 21,000 have gone into Army or Navy, and 3,000 have joined the Canadian service.

Other sums in the bill: maintenance and operation of airway facilities, $8,388,000; establishment of new facilities, $5,640,000.

1942 NAA Convention

June 6 to 9 is set aside for the 1942 NAA National Convention, in the Fontenelle Hotel, Omaha. NAA activities have been developing throughout the state of Nebraska where new chapters have been formed at Lincoln and McCook.

Air Course Contest

Closing date for the National Aeronautic Association's Air Youth scholarship competition, offering $12,000 in aircraft mechanics, airline maintenance, and engine mechanics courses, has been extended to May 15. Candidates are required to show they studied trigonometry, algebra, physics and chemistry; evidence of some worthwhile contribution in the field of aviation (or employment at an airport or other phase of aviation); submit a 1,000-word essay on "The Part Youth Can Play in America's Air Defense"; and obtain letters of recommendation. Major Lester D. Gardner, chairman of the Committee of Awards, pointed out that the need for skilled workers in the aviation industry is urgent. NAA's office is at 718 Jackson Place, Washington, D. C.

Instructors School for Glider

A glider instructors' training school has been put into operation at Twenty-Nine Palms Air Academy, Calif., under contract with the Air Corps. Two-place Schweizer machines are being used, and bigger ships of various makes, up to 12-place and more, will be used later. Twenty-Nine Palms has suitable topography for both slope and thermal work. Four types of tow are used: automobile, automobile winch, powered winch, and airplane. All of the students are young airplane pilots recently commissioned.

Pensacola Speeds Up

Pensacola Naval Air Station has gone on a seven-day week flying schedule, partly because spring rains cut down the number of flyable days. As this was written, the station was planning to go on two eight-hour shifts daily. Expansion of station facilities will permit receiving 1,000 more cadets a month.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

A Shimmer in the Sun

The fine art of illusion is so perfected on airports that even homing pilots sometimes fail to find them. All front fields are now camouflaged. In general, where possible, existing fields, orchards, barns, are left as is, and runways are laid out between them. Then the natural patterns are carried across the runways with painted burlap, or with other illusory devices. Sometimes dummy trees are stood on the runways, and taken down only for traffic movements. Planes are dispersed in the barns, in brush and trees, and in low sheds with camouflaged roofs. War department is working on new tricks constantly.

Even dummy railroads are put across airfields. The Germans once simulated gleaming steel rails by means of little channels of water in cement. But they forgot the ripple. British pilots noticed this, took pictures, which revealed the sham, went back and bombed the airport which would have gone unnoticed but for a shimmer in the sun.

That old question: Whether war planes will be put to civil use when peace comes, is brought up again—by the British. Capt. H. H. Balfour, under-secretary of state for air, says military planes must be improvised for two or three years' use after the war till civilian models can be developed. The day fighting stops, Britain's routes should start with military craft, he says, and they must immediately order 500 to 1,000 transport planes. He says nothing about private planes. In this country we will have later civil models and more of them than the British, Germans, Japanese, and Russians. If the world disarms, military planes will sell for a song. But in general they are pretty hot stuff for private or commercial use. Some of our trainers would be nice. Make your own prediction.

Most intriguing of all speculation on postwar doings is the question of new designs and new products. Washington and industry are only beginning to think of it. Some auto companies have already said they are storing their tooling and will start with 1942 models when the war ends. But suppose some independent concern starts with 1945 cars!—if the war ends then. Suppose some airplane company takes a notion to build a plumb new kind of car! Could the other manufacturers stick to their 1942 designs? Will the airplane builders go to work on jet propulsion? On all-wing design? On helicopters? Will jet propulsion be tried on cars and boats? You can ask yourself scores of such questions in all fields of technology—and you needn't feel like a Buck Rogers for it. Things are cooking.

The "Sister System" is a sort of liaison scheme between British and American firms turning out similar airplanes. The British firm gives advice on design and stresses in the latest modifications, and assists in the assembly of American aircraft in England. Of course every American firm that supplies planes to England has several representatives there. British aircraft builders say that their repair organization can deal effectively with a 60 percent crackup.

Barrage Balloon School

Training in handling barrage balloons has started at Camp Tyson, deep in central United States, only anchor balloon school of the Army. Trials in England convinced the Army that the entangling steel cables and nets are effective in keeping attacking airplanes at a high enough altitude to badly spoil their aim. Practically all planes that contact the mesh are seriously damaged or brought down. The cables are hard to see, even in the daytime.

For training purposes, bags are inflated with helium, but in combat they use hydrogen or other gases.

A long training period is necessary to make the crew of 22 men per balloon efficient. Each balloon has its carrier truck for the bag, gas supply, and supplies. Balloon units are highly mobile. Barrage balloons carry no weapons, and no persons: the cable and net.

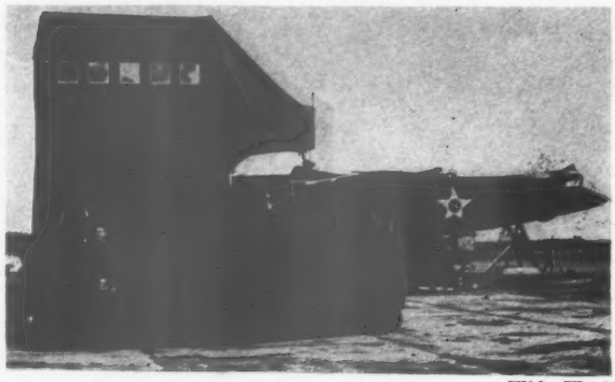
Some units have already been in service at strategic points in the country.

The public in general is warned not to approach any escaped balloon with any kind of fire whatever, as a strong explosion might result. Neither should dragging cables be touched, as they often pass over high tension wires.

B-25 to Our Allies

North American Aviation's B-25, named "The Mitchell" in honor of the late General Billy Mitchell, and credited with being the first of the Army's air force to sink a German sub, is now in use by all of the United Nations.

Output of these twin-engine long-range medium bombers at the already large California plant of the company, is being greatly augmented by the production at the new government owned assembly plant in Kansas.



Wide World

This mobile workstand, completely shielded against the elements, is wheeled up to the plane in field maintenance and repair work. Taken at a Northwest Pacific Base, photo shows partly dismantled B-26 on trailer.

Exact speed and range are military secrets, but the War Department says the bomber is "faster than most of the foreign pursuit planes," and adds its great bomb capacity makes it one of the most effective tactical weapons in this war. It is faster than similar German planes which do 300 mph., and British and Japanese which do 250 mph. The B-25 range is nearly 3,000 miles with full bomb load.

CALLING NAMES

Clay C. Crawford has been appointed assistant to the chief of the Bureau of Priorities to handle liaison between the Bureau and the Priorities Committee of the Army and Navy Munitions Board.

W. T. Graham of Fleetwings, Inc. has been named vice-pres. in charge of manufacturing to replace **C. M. Kaltwasser,** resigned.

Clarence O. Bell has been appointed manager of the Airplane Division of Goodyear's Aeronautical Sales Dept.

D. L. Urquhart becomes field asst. to the supt. of reservations and ticket offices for American Airlines, succeeding **H. M. Hollinger,** now on duty with the Army.

Republic Aviation Corporation recently has added **Victor Pixey, Joseph F. B. Parker** and **Duane J. Clapham,** all former Air Forces pursuit pilots, to its staff of test pilots.

Edward G. Lehnert former airport station mgr. for Northwest Airlines at Duluth succeeds **Richard G. Brew** as NWA airport manager at Milwaukee. Mr. Brew will take over at Duluth.

Robert E. Gilsdorf, former chief accountant of NWA, has been named office mgr. in the company's St. Paul accounting office.

William L. Littlewood, vice-pres. in charge of engineering of American Airlines, has recently rounded out his 15th year with the company.

Orvill S. Tuttle, former senior design engineer for Lockheed, has been named chief aircraft engineer of United States Plywood Corporation.

Alvin P. Adams has left Seaboard Airways to become president of Duramold Aircraft Corp. and **Hebert V. Thaden** is now vice-pres. in charge of production. **Joseph J. Mehl** also left Seaboard to become asst. treasurer of Fairchild Engine & Airplane Corp., owner of Duramold.

Ernest R. Breech is elected president of Bendix Aviation Corp., succeeding Vincent Bendix, who became chairman of the board.

Alfred Marchev, Chicago industrial executive, has joined Republic as assistant to the president.

Victor Pixey, Joseph F. B. Parker, Duane J. Clapham, all former Air Forces pursuit pilots, are added to Republic's staff of test pilots.

Mrs. Virginia Montonye is Consolidated's first women electric truck operator in the factory, while her husband is in service.

Wallace G. Kileen is appointed comptroller of the Eastern Aircraft Division of General Motors.

Milton H. Anderson is appointed director of the pilot training division of Northeast Airlines.

John T. Griffin of Quincy, Mass., is appointed assistant chief pilot of Northeast.

W. W. Fowler, senior captain of Trans-Canada's eastern service, is appointed operations superintendent, Maritime division with headquarters at Moncton, N. B.

Don R. Berlin will serve as aeronautical engineer on the staff of O. E. Hunt, vice-president of General Motors.

Glenn L. Martin, pioneer aircraft manufacturer, is honored as the "Man of the Month" at the Celebrity Forum luncheon of the Advertising Club of New York on Wednesday, March 11.

Roy W. Johnson has been named general manager of the Boots Aircraft Nut Corporation.

Wallace G. Kileen is now comptroller of the Eastern Aircraft Division of General Motors.

W. Gordon Wood has been appointed eastern traffic manager at Toronto for Trans-Canada Air Lines, while **V. H. Fulcher** has been named asst. to general traffic manager at Winnipeg. **Harry W. Ashburn** of Bell Aircraft was appointed chief planning engineer, and has been succeeded by **Harold L. Smeltzer** in charge of tool design.

J. N. Combs is now vice-pres. and treasurer of Aircraft Components, Inc. and **Oliver Raye** becomes secretary of the company.

Charles P. Hunt was appointed purchasing agent for the Menasco Mfg. Co.

Major General Hubert Reilly Harmon is now the commanding general of the Gulf Coast Air Corps Training Center.

T. A. Lynch has been elected vice-pres. of Reynolds Metals Co.

Joseph M. Barr and **James J. Gaffney** were appointed assistant general managers and **Richard T. Horner** as asst. treasurer and asst. secretary of the Vought-Sikorsky Division of United Aircraft Corp.

Lynn Reynolds is now vice-pres. and production mgr. of Adel Precisions Products Corp.

Tom M. Girdler is chairman of the board and chief executive officer of both Vultee Aircraft Inc., and Consolidated Aircraft.

A. D. Vollenweider is now chief engineer and **Dr. Charles N. Kimball** is executive engineer of the Kansas City division of Aircraft Accessories Corp.

Alfred Marchev, Chicago industrial executive, has joined Republic Aviation Corp. as asst. to President Ralph S. Damon.

John T. Griffith, former flight captain, has been named assistant chief pilot of Northeast Airlines.

Robert McCulloch has been appointed general manager of the Nashville Division of Vultee Aircraft, Inc.

Airlines Training Combat Pilots

Northeast Airlines announces a contract with the Army, through the CPT Division of CAA, for advanced instruction in cross country and instrument flight of pilots already licensed. Company has maintained its own school for multi-engine training; in 1941 it made a contract with CPTP for training of multi-engine instructors.

Northeast's Airline Training School has taken over all the space in a larger hangar at Commonwealth Airport; is operating 12 training planes, four of which are Lockheed transports; using six Link trainers in instrument work.

One other major airline has a training contract with the War Department on a somewhat different basis, and practically all of the lines have offered to serve.

Kids Build War Models

Air-minded youth of the U. S. began construction last month of the first of 500,000 scale model planes needed by the Navy for recognition and gunnery practice. Navy has asked for 10,000 models each of 50 different types of fighting planes. The first 20 types assigned include: Brewster, Vought-Sikorsky, Consolidated, Douglas, Grumman, Bell, Curtiss, Northrop and Boeing. Planes of England, Germany, and Japan were also asked. Thirty other types were scheduled soon to follow.

BASIC FACTS ABOUT PRINT MAKING YOU SHOULD KNOW

OZALID SENSITIZED MATERIALS ARE AVAILABLE IN CUT SHEETS AS WELL AS ROLL STOCK. Thus, when you have engineering drawings, maps or charts to be reproduced, you can eliminate trimming waste by using cut sheets of Ozalid material which correspond to the size of your tracings.

Ozalid cut sheets are conveyed through an Ozalid whiteprint machine the same as roll stock—without "leaders" —without the complex operations necessary with all wet development processes. By contrast, blue print material when cut from a roll must be processed by hand.

This is the fourth of a series of facts on modern printmaking. Watch for Fact No. 5.

PRINTS DEVELOPED DRY are permanent — true-to-scale of the original — made so quickly you're able to speed your entire production schedule!

The Ozalid Process of making positive-type whiteprints by dry developing sensitized materials in a whiteprint machine is simplified printmaking that will give you ***better*** prints ***faster!***

Ozalid whiteprints are made in two fast operations — exposure and dry development. They are never moistened by solutions—never washed or fixed as in blue printing—never wrinkle—curl—or fade in sunlight.

Standard Ozalid sensitized materials develop blue, black, or maroon lines on a white background. Transparent papers, cloth or foils produce duplicate originals which are three to five times faster printing than Van Dykes when making subsequent prints.

Whether you need large — small — or medium print production, there's a specific Ozalid machine to meet your demands—to enable you to speed production. By dry developing your prints you save in time — labor — materials.

Write today for an illustrated folder describing the many advantages of printmaking with the Ozalid Process.

SPECIFY *Ozalid* WHITEPRINTS

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GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N.Y.
Ozalid in Canada • HUGHES OWEN CO. LTD., Montreal

★ ★ ★ *The experience of General Motors is full-rounded and without bias in the airplane engine field. In addition to the liquid-cooled Allison engine, GM is under license to build air-cooled radial engines in its Buick and Chevrolet plants.* ★ ★ ★

Bell Airacobra
U.S. and British designation

Action speaks...

These news dispatches from the British fighting front tell more about the Allison engine's outstanding performance than might any words of ours.

U. S. AIRACOBRAS NEWEST THREAT TO NAZI AIRMEN

London, Oct. 18.—The royal air force has something new in store for the German air force's much vaunted Messerschmitt 109F plane. It is the United States-made Airacobra fighter machine, one of the most [illegible] of its kind anywhere in the world. At a large R. A. F. base "somewhere in England" there are a number of these hard-hitting, cannon-equipped, fast-flying Airacobras, all ready for action, with pilots eager to do battle with them against the German. A squadron leader in charge of one of the [illegible] units which have been introduced to these machines by a detachment of men from the United States army air corps—is supremely confident that the "Cobra" will prove vastly superior to the ME109F, in air [illegible] at what he called "low altitudes," but [illegible] say exactly what [illegible] "stratosphere."

AIRACOBRA RATED FASTEST FIGHTER BY BRITISH PILOTS

Design Cleanest of Any Ship Now in Use Abroad; Range Exceeds Even That of R.A.F. Spitfire

AT AN R. A. F. AIRDROME, Somewhere in England, Oct. 18.—Pilots flying the first squadron of American-made Airacobra pursuit ships to go into action against the Nazis described the Yankee plane, manufactured by the Bell Aircraft Corporation of Buffalo, as the fastest fighter ship now in regular operation with the Royal Air Force. "It has the cleanest design of any plane we are using," the commander of the recently organized Airacobra squadron told American newspapermen. "In speed, it is far ahead of the [illegible]. We are very pleased with its maneuverability, speed and with the liquid-cooled 1150 horsepower Allison engine with which it is powered. I am sorry to say that [illegible] have been able to get any Germans over the English Channel so far in actual combat.

"Whenever we've gone over, we've been bounced, and very rudely at that. But we've been in France [illegible] tough ones and the Airacobra is a better plane in every way. The plane, a pursuit ship, carries a .20-mm. cannon, two .50 caliber guns located in the nose of the fuselage, and two .30 caliber guns in the wings. The cannon shoots through the propeller, and four .30 caliber machine guns on the wings. The American model carries a 37-mm. cannon but the British prefer the smaller caliber because they want more ammunition for the destruction of enemy planes. The smaller-caliber cannon can carry more ammunition.

The tricycle landing gear is new to the R. A. F. pilots, but [illegible] trouble was experienced in landing. The pilots have been in operations over here principally at the take-off speed of the Spitfire, which is a good [illegible] Airacobra pilots have found that the take-off speed is [illegible] Spitfire.

Airacobra Best Pursuit Ship In Air, British Say

A Fighter Station Somewhere In England—Airacobras and outperform Spitfires at low altitude, though they prefer the Spitfires for high altitude.

(The Airacobra . . . it is reported to do better than 415 miles an hour . . . is said to be the fastest single-engined pursuit plane in production in the United States. It is unique in having its propeller driven by a shaft running beneath the pilot. It carries a 37 or a 20 mm. cannon, two .50 caliber machine guns and four .30 caliber machine guns.)

Colonel [illegible] Air Forces Flight Training Detachment at Selfridge Field, Mich., [illegible] put the Airacobra through operations, stood by while the squadron leader enlarged on the virtues of the planes.

"The Airacobras shot up a ship in a real ridding battle without any trouble and their machine guns functioned perfectly," he said. "Their base without exception. The Canadians, main fighters, they [illegible] Czech and New [illegible] are confident [illegible] formed Me[illegible]

More deadly armament thanks to the fact that the Allison engine permits cannon in the nose of the plane.

Curtiss P-40 (U.S.)
The British call it "The Tomahawk" or "The Kittihawk"

Lockheed P-38 Interceptor (U.S.)
The British call it "The Lightning"

North American Apache (U.S.)
The British call it "The Mustang"

LIQUID-COOLED AIRCRAFT ENGINES
Allison
DIVISION OF GM GENERAL MOTORS

Military Planes Now Have A-1-a Rating

To Boost Plants Toward Full Capacity

Washington (AVIATION Bureau)—Army and Navy war planes now carry an A-1-a priority rating. People who took the trouble to read this news were amazed; they had supposed that fighting planes were at the top of the preference list all the time.

But not so. For months, while military officials fought for ratings on various arms, heavy bombers and their engines were rated A-1-b; other airplanes engines were rated A-1-c; and airframes, A-1-d. Meanwhile, hoisting cranes carried A-1-a; conversion of ships, AA, the highest possible rating; merchant ships for delivery in 1941, A-1-a; for delivery in 1942, A-1-b; tanks A-1-f, etc. Last December tanks were granted an A-1-a.

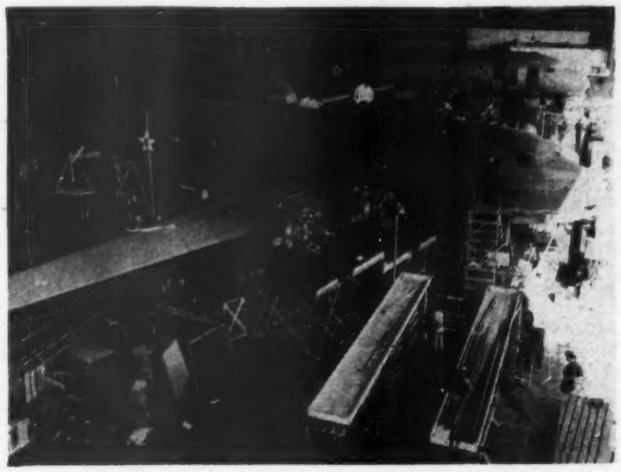
Before Donald Nelson became chairman of WPB, he recommended the highest rating for airplanes, but he didn't have the power to tell the Munitions Board. Each officer wanted preference for his own project. Sometimes the word of a brigadier general against that of a colonel turned the trick. But now, Nelson, the civilian, outranks all service men in matters of production.

Less-than-top rating for aircraft has slowed production, to what extent cannot be known exactly. But some plants could have worked their machines more hours, even more shifts, if they had had the materials. Some plants lost some subcontractors to other lines of war production that could get the materials.

But that's history. More important, the high rating now granted will enable manufacturers to get tools and will help some on materials and parts in the desperate effort to achieve the high rate of output necessary to meet the President's quota of 60,000 this year. It will take uninterrupted delivery and routing of materials to do that.

This struggle over preferences marks a new phase in this war of production. The first phase began with establishment of the priority system, the purpose of which was to take materials away from civilians and divide them strategically among the military needs. It ended when the Government stopped the delivery of silk, tires and automobiles to civilians.

The new phase begins now, as the Government discovers that, even with civilian production entirely stopped in some lines, there is still not enough of some materials to make enough war equipment. That is where the priority struggle between those responsible for airplanes, tanks, guns and ships begins. Nelson decides, and even with all the military advice he can get, the responsibility is great. No man can know exactly what weapons to rate high, because you can't call your shots in war till you get the offensive.



C-54's, military version of the Douglas DC-4, are now in quantity production for the Army Air Forces.

Detroit Triples Output

Just how big the airplane production job in Detroit is, you will not be told, but you can guess that it is the biggest of the several major war jobs there.

The total Detroit job, with automobiles practically out—only Army and Navy car orders are being filled—is three times as big, in dollars, as the industry's 1941 output.

Right now the place is a shambles of demolition, but some companies will make such progress on new war work that they will have as many workers in June as they had when the Jap war started.

Yards are full of single-purpose tools, moved out to make way for specialized machines to make planes, tanks, guns. When auto production was at full blast, parts flowed into assembly lines at the rate of $1,000,000 an hour. War production will be much faster. It will be equal to 15,000,000 cars and trucks per year. In 1929, the peak year, 5,358,000 motor vehicles were produced.

Following established practice, the industry will sublet a large volume of its total, probably two-thirds of it.

Aluminum Scrap Order

All aluminum scrap generated by aircraft and other plants in quantities greater than 1,000 lb. per month must be segregated by grades, in accordance with WPB Order M-1-d. The order in no way eliminates scrap dealers, who continue to collect scrap outside plants. They may purchase mixed scrap from plants producing less than 1,000 lb. per month. Dealers must sell all scrap to a producer or an approved smelter. The order provides that certain alloys in solid forms shall be sold and shipped directly to a producer by the plant generating the scrap.

Glenn L. Martin Co. in answer to America's call for more airplanes, reaches its full growth as the plants at Middle River are finished, quadrupling the size of the pre-emergency facilities. Tooling is largely complete and production rates have been reached on two of the three major bomber types to be turned out for Army, Navy and British, with the third type in the production stage.

Wide World

This view of the tool and die department of the Ford bomber plant near Detroit indicates progress being made in the auto industry's conversion to aircraft production. Partial production has begun at one end of the gigantic plant while steel work and masonry are still going up.

Weight Engineers Meet in Chicago April 27-29

The Society of Aeronautical Weight Engineers will hold its second national meeting at the Palmer House, Chicago from April 27 through the 29th.

The program is to be arranged as follows:

April 27—Military Projects.
April 28—Accessory Projects.
April 29—General Technical Projects.

The SAWE is a new but vitally important technical organization founded on the belief that the future development of aircraft depends to a high degree upon the application of research to weight control and to estimating procedures. By including the leading weight control specialists of the aviation industry in its membership, an interchange of ideas and data on the latest developments is made available to the industry.

The society was organized on a local basis in 1939 in Los Angeles, but since then has grown to a national organization of impressive stature with chapters throughout the country. The Chicago meeting, under the direction of 1942 Chairman Donald R. Watson, should prove to be a milestone in this important work and a definite contribution to the national war effort.

Engine Parts Plant

N. A. Woodworth Co., Ferndale, Mich., was allocated funds for additional machinery and equipment for production of precision aircraft engine parts. Company has been awarded about $15,000,000 in defense orders and its employees are working on the 24-hour-a-day, 7-day-a-week basis. Woodward attributes his high production rate to a systematic training of unskilled labor which qualifies them for skilled work; and plant equipment which is easily tooled for war work with a minimum loss of machine hours. Two of the three large plants are devoted to manufacture of parts, with the third to heat treating and plating.

First Forging Plant

The first forging plant in the U. S. operated by aircraft men exclusively for the aircraft industry is Aircraft Mechanics, Inc., of Colorado Springs, says Proctor W. Nichols, president. Forging activities will be handled by its newly formed Airforge Division. Company is engaged in airplane parts production with output going to manufacturers for Army and Navy planes. The new plant which adds a total of 40 tons of alloy steel forgings per month, brings the capacity to 120 tons per month.

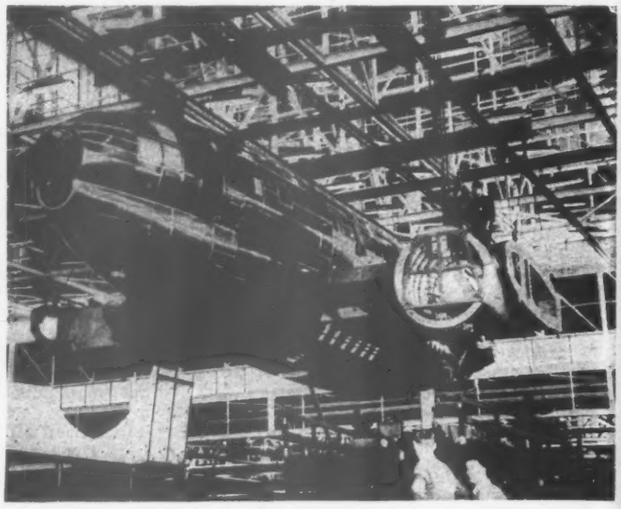
Try For 98,000 Feet

The Rome newspaper, Popolo Di Roma, reported an Italian engineer and a priest will attempt to reach an altitude of 98,000 feet in a stratosphere balloon flight from Mt. San Raffael in Argentina, according to United Press. Professors Picard and Cosyns, stratosphere experts, installed instruments in the gondola.

Light Plane Limit

The order from the War Production Board, L-48, limiting production of light planes under 500 hp., does not restrict needs of CPTP and CAP, and indicated that Army and Navy will be using large numbers, the NAA says. A CAP or CPTP member may purchase a plane if it is bought for duty, with the signed agreement that the buyer will retain it until not less than 300 hr. of use in the line of duty to be certified in its log book. Companion orders are expected on maintenance parts and tires.

Production of all-aluminum ships is barred but only affects one or two companies. After Sept. 1, construction is stopped on aircraft which have aluminum ribs and contain more than 18 percent aluminum in airframes, or planes with ribs of other material and containing more than 12 percent aluminum in airframes.



An overhead conveyor system helps to speed production of the C-46, Curtiss-Wright's twin-engined transport in quantity production for the Army Air Forces. Here one of the fuselages is being moved from the splicing fixture to final assembly department. It is broken down into 54 major assemblies to speed line production and expedite subcontracting of parts and assemblies.

Unified Hiring Offices

Fifty thousand persons are expected to be hired from the "world's largest employment office," which began operations in Los Angeles on March 6, with the backing of the United States Employment Service and seven aircraft manufacturers of the area. It will serve the Douglas, Lockheed, North American, Vultee, Northrop, Consolidated and Timm aircraft companies, 100 or more auxiliary aircrafters, and 1,800 subcontractors. It is expected that more than 100,000 persons will be "screened" through the office and 50,000 of them will be hired during the coming year. The unified employment office was developed by the Army Air Corps plant protection committee, to keep job applicants away from aircraft plants, now in restricted areas. The new office occupies 64,400 sq. ft. of space in downtown Los Angeles.

Buick-built aircraft engines for big bombers are rolling from the production lines at an accelerating rate. Harlow H. Curtice, right center, president and general manager, presents log sheet of an engine that has just completed its test run to Maj. E. H. Bowman, Air Corps representative.

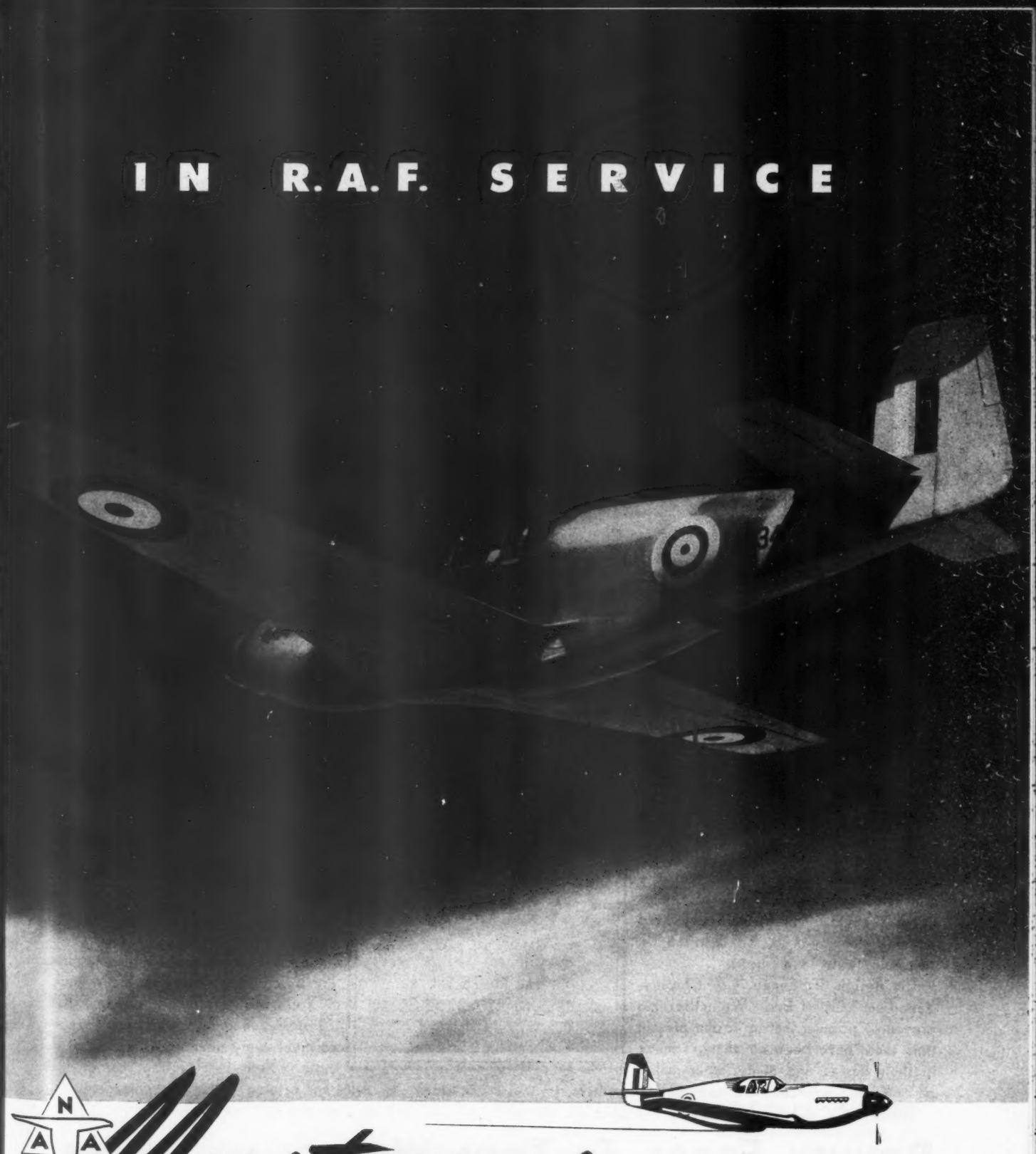
Navy Balloon Patrol

To work out of Lakehurst, N. J., the Navy has set up the first patrol squadron of a balloon patrol group. Others will float in and out of new stations at Elizabeth City, N.C., and South Weymouth, Mass., with several more on the West Coast.

Barrage Balloons Used

Barrage balloons are being used to protect military objectives in the Pacific Northwest. The balloons are moored by thin steel cables that would be invisible to enemy pilots but would cause any plane which struck them, to crash.

The balloons are about 100 feet long with outer skins of two-ply rubber. They present a real hazard to enemy craft.



Mustangs

ARE "BUCKING" INTO THE
JOB OF DEFENDING BRITAIN

NORTH AMERICAN AVIATION, INC.
Inglewood, Calif.

The Finest that Money Can Buy

BONNEY 'CV' *Chrome-Vanadium* Open End Wrenches . . . . the original wrenches made of alloy steel

BONNEY TOOLS

IN July 1923 . . . . almost 19 years ago . . . . Bonney announced the 'CV' *Chrome-Vanadium* Open End Wrench . . . . the original wrenches made of alloy steel.

The use of 'CV' *Chrome-Vanadium* Steel permitted the complete re-design of openend wrenches. Heads are pear-shaped, narrower and thinner . . . . permitting the wrenches to be used in exceptionally close quarters. Handles were made long and thin, making a lighter wrench than the formerly accepted carbon steel wrenches with the same size openings and one of exceptional strength. This in turn permitted extreme leverage to be applied in adjusting nuts and bolts.

The design of Bonney 'CV' *Chrome-Vanadium* Open End Wrenches has proven so popular that up to the present time there have been no changes made in their design and many other makes of open end wrenches are patterned after them.

Bonney 'CV' *Chrome-Vanadium* Wrenches are the most popular wrenches in the tool kits of tens of thousands of mechanics in every line of industry. Drop forged and carefully heat treated their entire length to bring out the ultimate strength of the steel, they have accurately milled openings that grip the nut or bolt firmly. Made with 58 different combinations of openings . . . . openings range from 1/4" to 1 5/8" . . . . and lengths from 3" to 15 1/2" depending upon the size of the openings, they have a rust-resistant finish.

The No. 25 Set

Contains 6 'CV' Chrome-Vanadium Open End Wrenches with the most popular combinations of openings in leatherette roll. Openings included are 3/8" & 7/16"; 1/2" & 9/32"; 5/8" & 11/16"; 5/8" & 25/32"; 3/4" & 7/8" and 15/16" & 1".

Bonney 'CV' *Chrome-Vanadium* Wrenches are fully guaranteed . . . . "guaranteed to strip the thread or break the bolt before damaging the wrench".

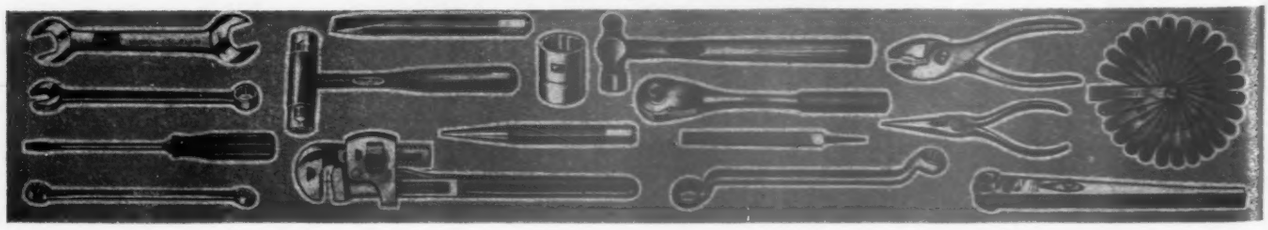
You, too, will find Bonney 'CV' *Chrome-Vanadium* Open End Wrenches to meet every need for wrenches of this type. Your local jobber carries them in stock—or write for catalog giving the complete range of sizes and showing the full line of Bonney Tools.

BONNEY FORGE & TOOL WORKS, Allentown, Pa.

In Canada—Gray-Bonney Tool Co., Ltd., Toronto

Export Office—38 Pearl St., New York, N. Y.

Stocked by Leading Jobbers Everywhere



Martin Test Flys New Navy PBM-3

The first of a new series of patrol bombers has been launched and successfully test-flown at the Glen L. Martin Company plants in Baltimore.

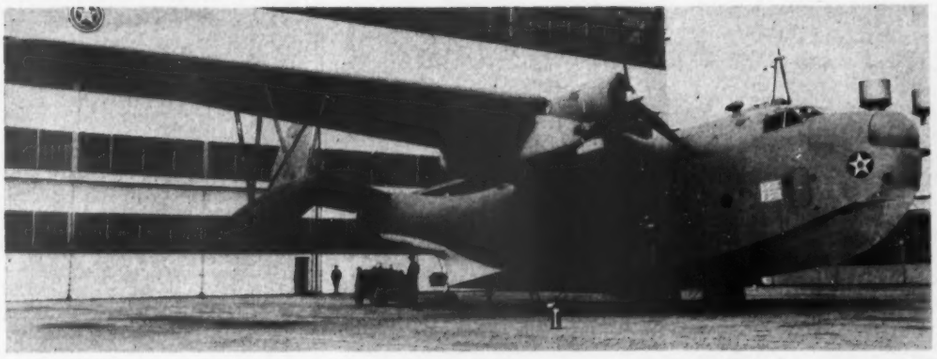
The new twin-engined ship, built for the U. S. Navy, is to be known as the "Mariner," (Navy PBM-3). The new ship resembles, in some respects, the Martin PBM-1, now in service with the naval forces. Bigger and more powerful than the PBM-1, the "Mariner" has the same gull-shaped wings and toed-in rudders.

The accompanying photograph reveals, however, that the production model does not incorporate the retracting wing-top floats.

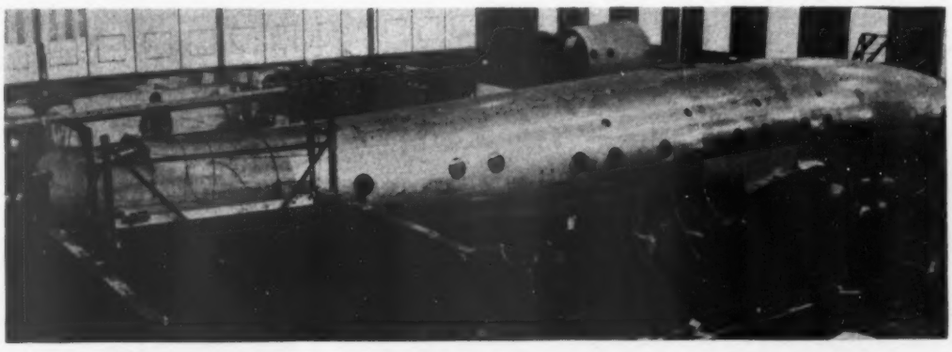
The new ship was test-flown her first day in the water, with Engineering Vice-President William K. Ebel at the controls. Ebel and members of his crew were pleased with the results.

Elaborate tooling, designed to speed quantity production of the PBM-3 has been installed at the Martin plant.

The "Mariner," joins the B-26, medium bomber for the U. S. Army Air Forces, and the "Baltimore" for the British as one of the three types of planes on which Martin will concentrate its production efforts.



The "Mariner," designated PBM-3 by the Navy, is the newest in a series of distinguished long-range flying boats built by Glenn L. Martin Co. Initial flight tests have been completed. This is one of the three types on which Martin will concentrate production efforts.



Construction of the new Lockheed Constellation, built for TWA, is progressing rapidly at the Lockheed Burbank plant. This giant plane will carry 57 passengers and a crew of seven.

ASSEMBLY LINES . . . By Dorsey Adams

Aeronca, in line with its "stepped up efficiency" plan, has set aside a sum of money to establish and maintain an "Aeronca Victory Award." These awards of gold medals, parchment acknowledgments and defense stamps and bonds are to be awarded to workers in the plant for suggestions for turning out better parts or improving production operations. Employees themselves will handle victory awards and ideas and designs will be judged by a jury of co-workers in executive positions within the plant. Actual presentation will be made by Army officers or outstanding civilian figures in the aviation industry.

Curtiss Propeller Division, Curtiss-Wright Corp., granted a wage scale graduated to the labor department's monthly index figures in a labor contract pegged to living costs. Signed with the Propeller-Craft, Inc., an unaffiliated union, it brought wage increases of 5 to 13 cents an hour immediately for employees in the company's Clifton and Caldwell plants. It provides that if index figures advance five points above the Feb. 15 level and remain at that point for 30 days, the workers will receive an automatic increase of five cents an hour. Similar increases are provided for each sustained five-point rise. If the index advances 20 points or more, the union may demand a general review of its wage rates. It also provides that if the index declines, wages will be reduced accordingly, but not below present level. The agreement is signed for one year and contains a "no strike" clause.

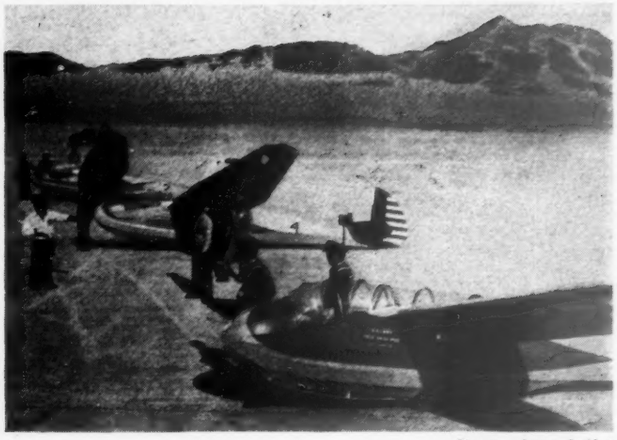
Briggs Manufacturing Co., with over $375,000,000 in orders on its books, announced that its dollar volume production rate, when full schedules are attained, will be twice as large as formerly, and its employee rolls will far exceed previous 23,000. Seven plants and equipment in Michigan, Ohio and Indiana are already turning out aircraft, tank and other parts in large volume, or being tooled up for new war jobs. The entire organization is devoted to war work.

Breeze Corporations, Inc., of Newark and Elizabeth, N. J., announced production and deliveries of defense equipment, to which 99 percent of its facilities are devoted, vastly increased in 1941 over preceding 12 months, because of rapid adaptation of equipment to war work. Several years ago, company developed aircraft products on many of the machines it used for the manufacture of automotive equipment and other products, says J. J. Mascush, general manager. Breeze succeeded in adapting its system of electroplating auto equipment to similar treatment of non-conductors for radio ignition shielding, which it pioneered for aircraft engines. It now produces tank, warship, and aircraft assemblies, and ground defense equipment.

British Aeroplane Engines Ltd., which has paid-up capitalization of $50,000 with registered offices at 248 McCord Street, Montreal, Quebec, and branch offices at Sea Island Airport, Vancouver, B. C., is one of two airplane concerns incorporated in British Columbia as Extra-Provincial Companies. Canadian Wright Ltd., engaged in the same field, maintains a branch at the Sea Island Airport in Vancouver, and has also been incorporated in B. C. Head offices of this company are at 6259 Notre Dame Street East, Montreal, and paid-up capitalization of the firm is $90,349.

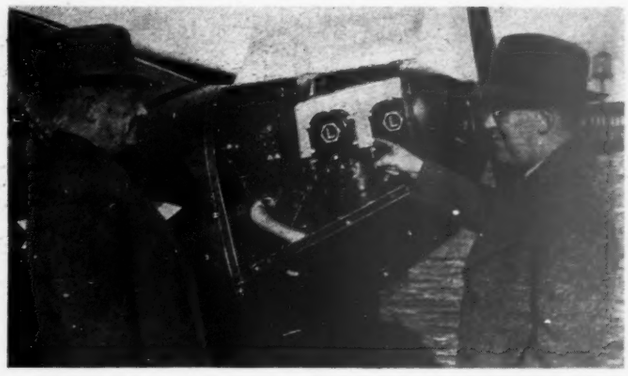
Plant Conversion Industries is a new firm organized in New York as consultants and engineers in plant conversion for war production. They say that about 95 percent of war production orders goes to only about 5 percent of our plants, which leaves 95 percent of business men wondering how to equip, retool, finance and produce war materials so as to maintain American morale and speed up war production.

Republic Aviation Corp., producers of the Thunderbolt pursuit, took first place as New York's safest plane-manufacturing plant, in the 1941 New York Statewide Accident Prevention Campaign, Aircraft Division. Three other major aircraft manufacturers competed. Company's victory revealed that the local plant had the near-perfect record of 99.924 but was closely-pressed by the other competitors. Less than three-hundredths of a point separated all four companies.



Press Association

Aviation cadets receiving instruction just before being towed into the air at the Army's first glider training school in the desert near Twenty-Nine Palms, Calif.



William F. Wise, executive vice-president of Aviation Corp. of which Lycoming is a division, and P. E. Garlent, division manager, inspect a Lycoming "100" installation in a Piper super cruiser. It developes 100 hp. at 2,550 rpm. and consumes only six gallons of gasoline per hour at cruising. The 25-gal. capacity of this ship make it ideally adapted to CAP flying.

Blimps Drafted by Navy

Two Goodyear "blimps," Resolute and Reliance, have been taken over by the U. S. Navy Inshore Patrol, for regular patrol duty in the southern California area. Members of the regular maintenance crews employed by the Goodyear company were sworn in to naval service by Lieut. Comdr. George T. Howe, U.S.N. on March 2.

ATA Goes to Washington

For the first time in its 15 years of existance, the Air Transport Association has its headquarters in Washington. Like many other organizations, and some government branches, it occupies one of big dwellings long since abandoned by the dwindling rich.

The address is 1515 Massachusetts Avenue, Northwest. All your old friends are there: Col. Edgar S. Gorrell, Sam Barker, "Red" Redfern, Harold "Hi" Little, and staff.

The Association came to Washington to cooperate more closely with the various branches of government which are vitally interested in the transport system as a major part of the war job, and especially with Col. Donald Connolly, Military Director of Civil Aviation. Incidentally, ATA managed to get larger quarters at less cost than it had in Chicago—contrary to the rule in booming Washington.

Martin Saves Aluminum

Glen L. Martin reports to the Industrial Salvage Section of the War Production Board that scrap-aluminum recovery has risen to 90 percent of the company's waste metals this year. It is expected that Martin will also salvage some 4,000,000 lb. of waste paper in 1942—paper which otherwise would have been burned.

Methods have been found to recover the higher-grade alloys and put them back to work without lowering their efficiency, says Harry F. Vollmer, vice-president in charge of manufacturing. Until now Martin has burned all of the large amount of waste paper under the eyes of armed guards, because it contained much valuable information.

But in view of the shortage Martin has worked out a shredding and baling technique which protects their paper from prying eyes.

3 Generals Transferred

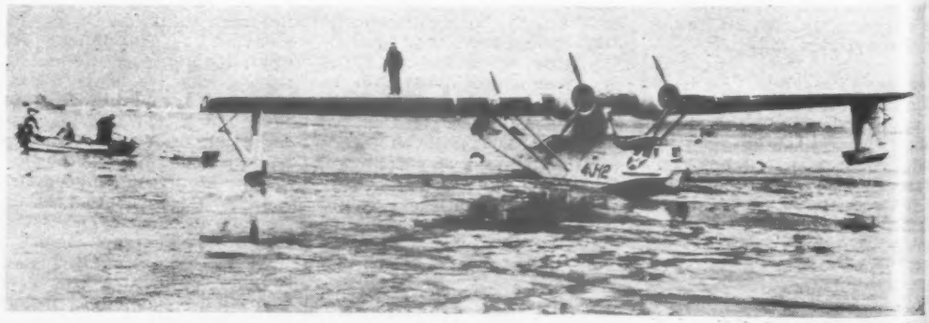
Three general officers of the Army Air Forces have been ordered transferred to new stations in connection with the expanding Air Corps training program, the War Department states.

Major General Barton K. Yount has been ordered relieved of duty as commanding general of the West Coast Air Corps Training Center, with headquarters at Moffett Field, Calif. He has been assigned to duty in the Office of the Chief of the Air Corps in Washington. Brig. Gen. Ralph P. Cousins has been relieved of duty as chief of the A-1 (Personnel) Division of the Air Staff and ordered to replace Gen. Yount.

Thiokol Corporation has purchased two large sections of the former Murray Rubber Company plant for the production of synthetic rubber latex for war equipment. Fuel tanks made of this latex, the cocmpany says, is highly resistant to the benzol-type fuels which are expected to become standard aviation fuels for the duration.

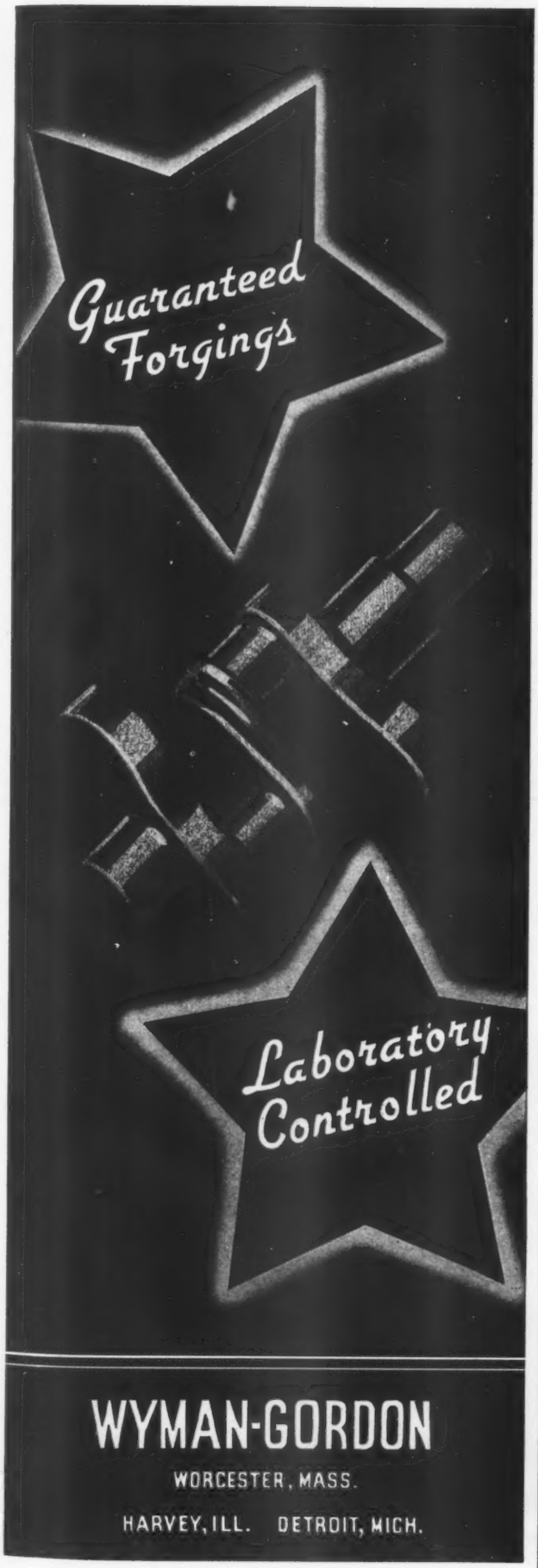
Associated Press

A rear gunner takes his station in an Army bomber prior to takeoff from an Eastern air base. Note how gunner lies on his stomach to operate gun.



Press Association

Patrolling under difficulties. Navy's PBY patrol boat is towed through ice flows to open water for takeoff on its ceaseless sub-hunt in North Atlantic waters. Scene at Naval Air Station, Squantum, Mass.



WYMAN-GORDON

WORCESTER, MASS.

HARVEY, ILL. DETROIT, MICH.

Have you read and acted on the announcement on pages 158 and 159

AVIATION ABROAD

Canadian News

By JAMES MONTAGNES

To replace members of its staffs from coast to coast who have been called for military service, Trans-Canada Air Lines, the publicly-owned transcontinental airline, is to open a personnel training school at Winnipeg. Women from 21 to 28 will compose the bulk of the students, although men exempt from military service are being sought. The students will be paid to go to school and will be employed for the duration of the war on successful completion of their courses. The school term will last two months and provide training in airline reservations, communications, airport passenger service and passenger sales.

TCA stewardesses are being given extra courses in meteorology, communications, aircraft structure and flight operations, so they will be able to answer the more technical questions they are being asked these days. Stewardesses in addition to their knowledge of food service, tickets, and schedules, must know considerable about the topography of Canada. Women are also being used in TCA shops for maintenance work, where they are doing a good job, it is understood.

In view of TCA's considerable war work, including the overhaul of aircraft and accessories for the Royal Canadian Air Force, special precautionary measures have been taken. All company materials carried from one point to another are now covered with a written record. The record accompanies the shipment to its destination so that it may be readily examined at any time. All members of TCA crews, including the stewardesses, take the oath of secrecy and allegiance. Identification buttons are worn by the staff at all the company's principal servicing points across the Dominion.

TCA has been authorized by the Newfoundland government to operate 10 hr. mail and passenger service between St. John's and New York via Montreal.

W. Gordon Wood has been appointed eastern traffic manager for TCA, with headquarters in Toronto. A graduate of Pennsylvania University, he joined Pacific Alaska Airways in 1935, a gold mining company later as diesel engineer, and in 1939 joined TCA as traffic manager at Ottawa. V. H. Fulcher has been appointed assistant to the general traffic manager with headquarters at Winnipeg. Other TCA traffic department changes include G. E. Gray from Toronto traffic manager to that post at Montreal, J. J. Robinson, from the traffic department in Montreal to the post of traffic representative at Toronto, and W. R. Campbell appointed city traffic manager at Ottawa from a traffic department post at Toronto.

International News Photo

Fokker T.S.W. seaplanes of the Royal Dutch Naval Air Service are assisting the RAF in safeguarding British shores and escorting convoys. They are manned by Dutch combat crews and serviced by Dutch personnel.

First company of the many acquired in northern Canada by the Canadian Pacific Railway to change its name in United Air Services at Edmonton, which now becomes Canadian Pacific Airlines Ltd. Other companies are expected to come under the new name as the merged organizations are gradually unified as to operations. Appointments in the CPR airways division include C. R. Troop to be general supervisor of the seven flying schools and four aircraft repair shops which are now unified in one department; W. R. "Wop" May, famed western Canadian airman, to be supervisor of schools for western Canada with headquarters at Edmonton; W. W. Woollett, supervisor of schools for eastern Canada with headquarters at Toronto.

Wing Commander Douglas Joy, of the Civil Aviation Branch, Department of Transport, Ottawa, has recently had published a booklet *Civil Flying Control and Regulations*. The publication (Sir Isaac Pitman & Sons) deals with air traffic rules, the story of the International Commission for Air Navigation, and a brief history of civil flying in Canada. It also includes airport construction, personnel, commercial companies, aerial navigation, traffic signals, radio operations, accidents and international traffic.

Canada's production of twin-engined Bristol Bolingbroke and twin-engined Avro Anson bombers is mounting. Canada is also to shortly start making airplane engines for Fairchild trainers. The Ranger engine is to be produced at Ontario plants of the Chrysler Corp.

In the 30 months during which Canada has been at war, the Canadian aircraft industry has increased its floor space more than tenfold. Every Canadian plant is booked solid until at least Dec. 31, 1943, and some into 1944 and 1945.

Canada's fighting airmen have proved fitting and worthy successors to the great Canadian airmen of a generation ago, to Bishop, Barker, Collishaw, McLeod and to many other great Canadian aces, garnering through their gallant exploits 157 awards for bravery and distinguished conduct under fire during the less than two and one half years of aerial warfare. In a report on decorations issued by the Royal Canadian Air Force in February 1942, it was shown that Canadians serving with the Royal Air Force had won 133 decorations, and 24 serving with the Royal Canadian Air Force at home and abroad had been given decorations. Three Canadians had been decorated by the Czechoslovak government-in-exile and one by the Polish government.

British Combine

Completed fuselages and wings of Britain's four-engine Stirling bomber awaiting final assembly. This is the bomber which has played such an important role in long-range British raids.

News Notes From Britain

By DR. GEORGE ABRAMSON

Up to 70 percent of all employees in aircraft factories might be women in the view of Sir Charles Craven, controller-general to Britain's Ministry of Aircraft Production. Hundreds of thousands of people will be needed by the aircraft industry within the next 15 months, and however inexperienced women are they can play an important part. The experience of British aircraft works managers has been that for repetitive work women are, if anything, superior to men. Their numbers in aero engine and airframe factories have been increased many times over, and concentration on modern types of simpler construction and splitting-up of production into simple parts tends to enhance the scope of female labor. Women are found to be adaptable pupils in government training centers, and firms with classes of their own have gained the same impression. Many women are now trained as draftsmen and for other skilled jobs.

Mr. William P. Hindred, now head of the Department of Civil Aviation in the British Air Ministry, who has recently returned from a visit to North America, said that the chief impression gained by the traveler on the transatlantic service was one of the thoroughness of the ground organization and weather forecasting which made the actual flying seem like an incidental hop from one airport to another.

The Iberian Peninsula, on three sides surrounded by water, is not only an important junction for European air communications with Africa and America, but aviation is the only safe mail route left to Spain and Portugal now that most other Continental countries are under German rule. Spanish statistics for the first half of 1941 indicate further rapid progress. Two hundred tons of mail and newspapers were received, against 234 tons in the whole of 1940; 190 tons were sent off by air, against 217 tons for all of 1940; 530 tons of goods were brought by airplanes (951 tons in 1940) and 580 tons were exported in the same way (1,062 tons in 1940). A total of 3,300 machines landed on Spanish airports (5,242 in 1940) bringing 22,000 passengers (37,208 in 1940). Transit traffic did not increase at the same rate, as planes on their way to and from Lisbon avoid calling at Spanish airports. Iberia Airline has resumed its service to Majorca, Spanish island in the western Mediterranean. Planes now connect Madrid with Palma.

British Empire airliners have cut out many of the luxuries which spoiled customers of civil aviation have come to take for granted, with the result that each plane on the Empire route is capable of carrying another 1,000 lb. Interior furnishings have been stripped, stewards and their baggage are left behind, and passengers take their turn as "ship's adjutant."

The French government is preparing for important changes in the relations with the leading French aviation companies. All agreements with Air France are to be terminated, and the South American concession has been withdrawn from Air France Transatlantique. These measures are in line with French official policy with regard to shipping lines.

The first official details about the Avro Manchester, the twin-engined heavy bomber in service with the RAF, have now been published. The machine is 70 ft. long, 19½ ft. high and has a wing-span of 90 ft. Constructed of light alloy throughout, the fuselage is divided into five portions to ease transport. Special features are flaps for improved take-off, excellent cabin heating system, electrically-operated de-icing equipment for tail unit, wireless mast and propellers. The center section of the wing is rectangular in plan form, the outer wing tapering nearly symmetrically from the engine nacelles to the rounded wing tips. The wings, of cantilever structure, are tapered in plan and elevation from the point where each wing is joined to the center section.

British Firm Seeks U. S. Business

Alfred Partridge & Co. Ltd., Bradbury, Stockport, England, have offered their services to stimulate business relations between U. S. manufacturers and the British market.

Among its services, Partridge offers complete representation of any American engineering product, part or whole manufacture of such product in England, development in the British market of any new commodity such as plastics etc., and sales, service and stock facilities for U. S. goods directly imported.

The British firm calls attention to the wisdom of preparing now for a progressive post-war policy.

ON SCHEDULE . . . by "Vista"

More than a year ago, the first hints were dropped that there were landplanes in a development stage which rivaled the Boeing Clippers for size. A short time ago more details were announced by Lockheed and TWA, for whom this transport is being built, together with Pan American. These planes will be able to span the oceans at a cruising speed of 285 miles at some 30,000 ft., their range will be over 4,000 miles, and will carry 57 passengers. The first plane is expected off the assembly line in July, and will shortly thereafter be seen in South America and England, where extensive plans for their reception have been made for some time, depending of course on the Army's approval of their delivery to the commercial airlines.

There is much argument in England as to the relative value of heavy bombers in an air offensive—based on the fact that German raids have failed to either cowe or frighten the British people, much less reduce their production rate. Some experts advocate the immediate cessation of all heavy bomber production-en-masse, with an increase in super-fighter construction, both of the single and twin engine type. They argue that the heavy bomber should be used for assistance to ground operations or strategic raids, with an eye on the loss of manpower in large scale raids, which is often serious. The powers-that-be seem to have different ideas, but in the meantime production on smaller heavy bombers was stopping and attention focussed on the new "Lancaster." The outcome of the argument will be interesting, especially in view of the 1000-bomber-a-month program over here.

No news at all has been received about the fleet of the KLM and KNILM in the East Indies, which consisted of a goodly number of modern transports, among which some ten DC-2's and DC-3's, four DC-5's, taken over from the KLM, five Lockheed 14's and some old Fokkers, which were used for general utility work. It is to be hoped that the indomitable Dutch have again succeeded in ghosting away these valuable transports to Australia, where they will be sorely needed for the coming United Nation's offensive.

Rangoon was once the terminal for the CNAC line to Chungking, but when this city's fall became too close for comfort, a new line was started to China from another, still undisclosed, city in India. First use was made of this connection by Generalissimo Chiang Kai-shek, and reports indicate that a regular air cargo service will be established as soon as the transports promised by the United States have arrived.

On February 27th., Pan American Airways completed the 500th crossing of the Atlantic, since the start of this service on May 20, 1939, when the first flight with mail was made, to be followed on June 28 with the first passenger trip. Another line will soon start operations across the Atlantic, when American Export Airlines completes the tests and shake-down flights with the Vought-Sikorsky VS-44-A delivered a few months ago. Both Panam and Export will operate to Foynes, Ireland, during the summer months, where they will be met by the BOAC CW-20 "St. Louis", which was delivered to the British and flown across a short while ago. As mentioned above, the next development will be the first flight of the Lockheed "Constellation," which should come before the end of the year.

GENERAL CONTROLS HIGH PRESSURE SELECTOR VALVES

REMOTE OR AUTOMATIC, ON AND OFF, POSITIONING OR "INCHING" CONTROL

General Controls Selector Valves assure positive control of hydraulic fluids, oils and gasoline, regardless of mounting position, vibration, or acceleration, i.e., substantial increases in "g." Type AV-7, 4-way high pressure selector valve illustrated above is for hydraulic control, proportioning, positioning or "inching," or the more complicated selector valve arrangements.

Here are the more important features of General Controls Aircraft type electric magnetic valves: light weight; compact design; extremely fast operation (to less than 1/100th of a second is practical); continuous or intermittent duty or other electrical variations; pressure range, from zero to 1,500 lbs. or more.

The complete General Controls AV Series includes valves for engine priming, gasoline cross feed, oil dilution and fuel control to heaters; for handling hydraulic and anti-icing fluids, oils, gasoline, air or other gases. These valves are available in single seated, normally open or closed or relief types, 3-way and 4-way types. For special applications, valves will be developed to specifications. Send for descriptive Bulletin.

Type AV-11; 3-way hydraulic control valve; 1500 lbs. or higher.

Write for Specifications and Valves for Inspection and Test

GENERAL CONTROLS

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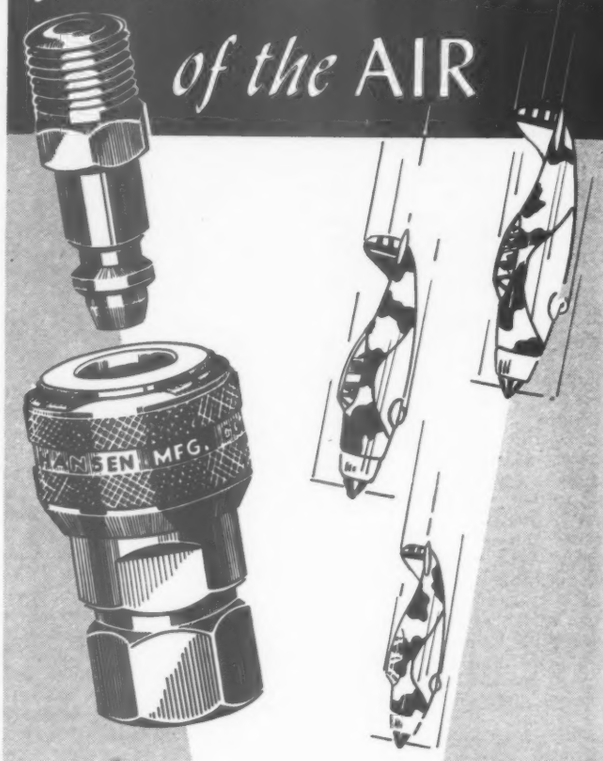
Absolute CONTROL *of the* AIR



HANSEN *Push-Tite* AIR HOSE COUPLING

Regardless of the air pressure Hansen *Push-Tite* air hose couplings are absolutely air tight with no leakage, which means control of the air at all times. This remarkable coupling is being used by the Army, Navy and practically all the leading aviation plants in the country, plus a great many of the large industrial plants.

Hansen *Push-Tite* air hose coupling is unique in that it speeds up production, is rough and tough, absolutely dependable, easy to operate, saves time and air. Its simplicity in construction means more efficient operation, less trouble and much longer life; a truly great coupling. A slight push of the plug into socket and it's connected, absolutely air tight and the air is automatically turned on, a gentle pull and it is disconnected and air is instantly turned off.

Complete swivel action of coupling eliminates entirely any twisting or turning of parts in order to connect or disconnect, also eliminates kinking of hose. Write for free catalog.

Hansen MFG. CO.

INDUSTRIAL AIR LINE EQUIPMENT

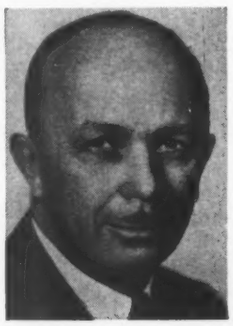
1786 E. 27TH STREET • CLEVELAND, OHIO

THOMAS O. HARDIN, former chairman of the CAA Safety Board has been appointed airlines consultant for the Pratt & Whitney Division of United Aircraft Corp. to supplement activities of the airlines service department.

RUSSELL CREIGHTON (left), who has been in charge of production engineering, has been named a special assistant to Bell Aircraft Corporation works manager, Lester L. Benson. Succeeding Creighton in charge of production engineering is JOSEPH B. BAUER (right). Mr. Creighton came to Bell Aircraft in 1940, and organized the cost estimating system now used before being named production engineer. Mr. Bauer is an aeronautical engineer of wide experience as well as a veteran pilot.

COLONEL CLAIRE L. CHENNAULT, U. S. Army retired, leader of the famed International Air Force in China composed of fliers who have resigned from the U. S. Air Forces. The Japs have proved to be no match for Chennault's men.

DONALD R. WATSON of Fleetwings, Inc. is the 1942 chairman of the Society of Aeronautical Weight Engineers, Inc. which is to hold annual technical meetings in Chicago's Palmer House in April. (See News Section.)



American Airlines Inc. has announced the election of HUGH L. SMITH as vice-president in charge of operations. Mr. Smith is a veteran flyer and was formerly operations manager for American Airlines.

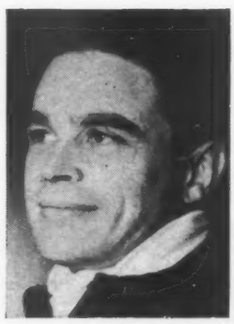
D. C. ANDRESS, formerly production engineer for Pratt & Whitney is now production engineer for the Kansas City division of Aircraft Accessories in charge of all production operations there.

A. J. FISHER is director of the Aircraft Section of Fisher Body division of General Motors, now engaged on one major bomber subassembly program as well as producing numerous aircraft parts and bomber sections.

DON R. BERLIN, formerly director of military engineering of the airplane division of Curtiss-Wright and designer of the famed Curtiss P-40, has joined the staff of General Motors as aeronautical engineer.

ERNEST R. BREECH was elected president of Bendix Aviation Corp. upon resigning as V. P. in charge of aviation for General Motors. He was also formerly chairman of the board of No. American Aviation, Inc.

JOHN ELBRIDGE PARKER is a newly elected member of the board of directors of Northwest Airlines. He is a member of the investment banking and brokerage firm of Auchincloss, Parker and Redpath, Wash., D. C.

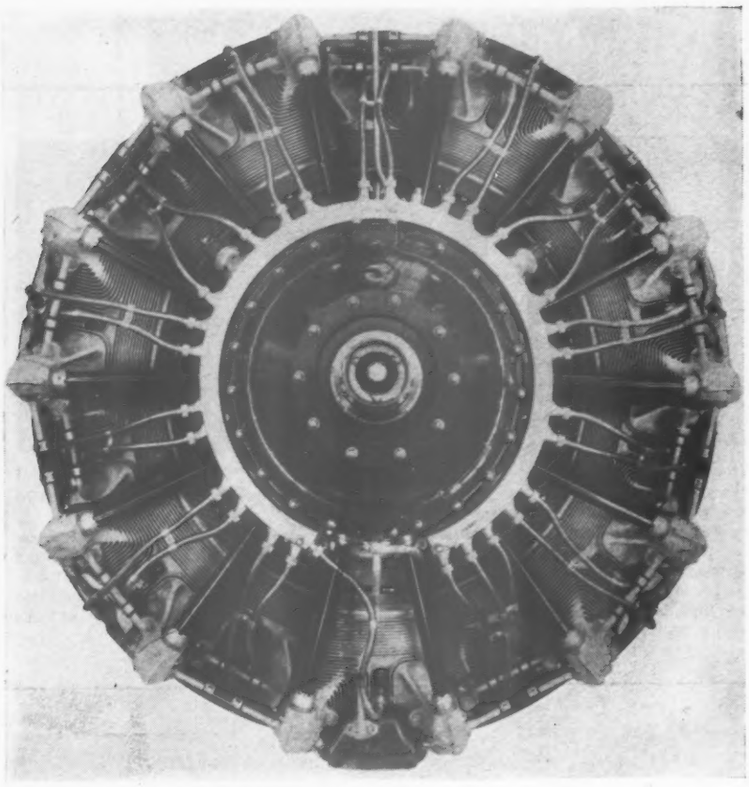


FRANCIS LIEBER has been appointed Bell Aircraft Corporation's sixth test pilot. He was associated with Aero Insurance Underwriters as a flight advisor at the time he joined the Bell Organization.

Curtiss-Wright Propeller Division has made two important changes in its staff recently. EDWARD F. THEIS (left), a well-known production executive in the steel manufacturing field, has been appointed plant manager of a Middle West factory of the division. MATHIAS KLEIN (right), has been promoted from manufacturing superintendent of a Middle Western plant of the Curtiss corporation's Propeller Division to chief production engineer of that division.

GEORGE THARRATT has joined Adel Precision Products Corp. as chief engineer, succeeding Lynn Reynolds who has been made vice-president and production manager of the Burbank accessory firm.

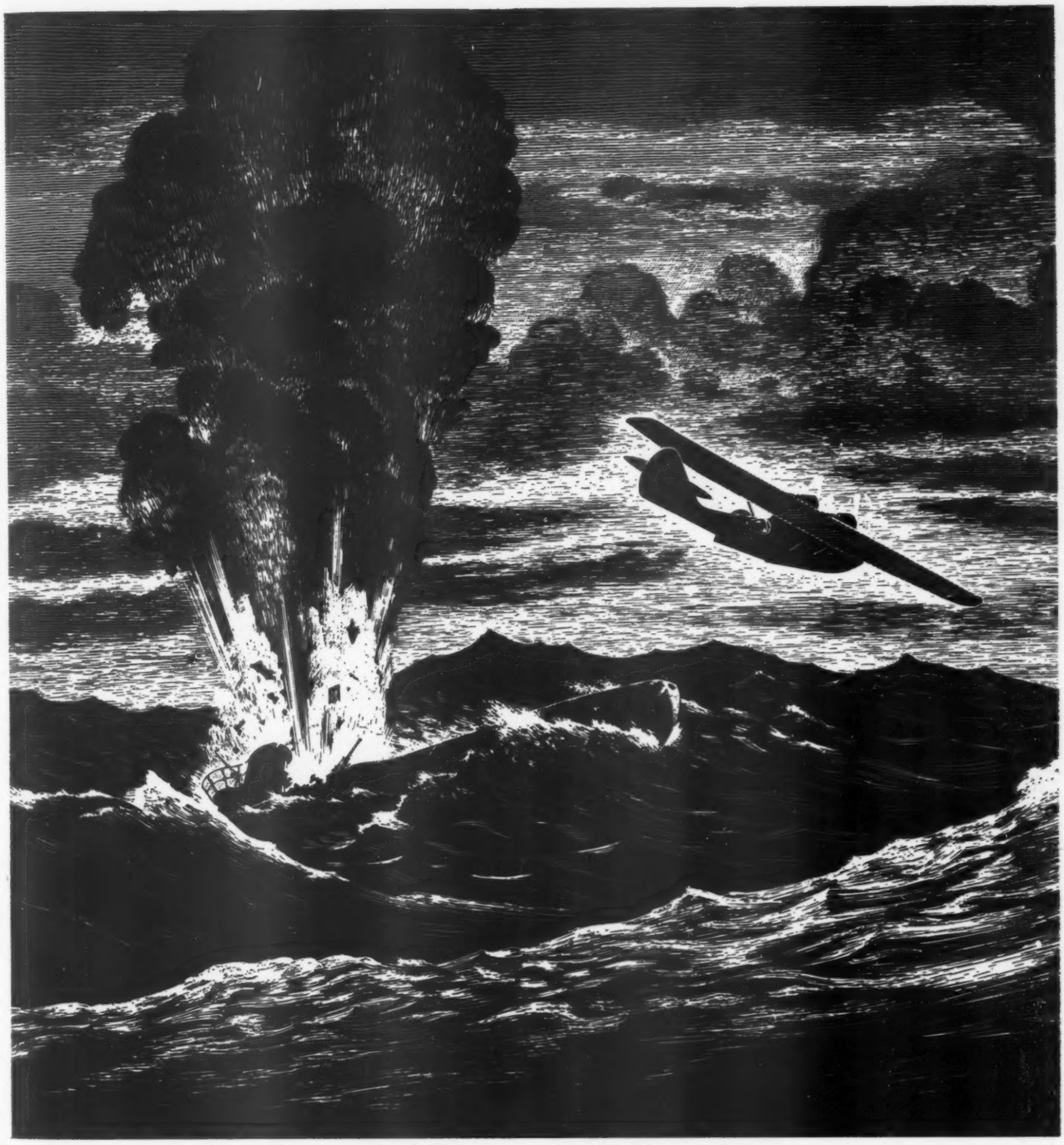
Ready To Fly On SKF



BUILT BY PRATT & WHITNEY

As one Pratt & Whitney engine after another is hoisted off ever-lengthening assembly lines and placed on giant bombers, fast pursuit planes, spunky fighters, long-range observation planes, and alert interceptors, you'll find SKF Bearings depended upon for *reliability.* For in today's far-flung outposts of Democracy the dependable performance of airplane engines is *vital* to Sky Supremacy. Good engines and good bearings always go together. 4981

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA.



BONDS FOR BOMBS! Back of every action against the enemy is the purchase of Defense Bonds. Each bond you buy strikes a timely blow in your Country's fight for freedom. Buy regularly - every payday.

Consolidated Aircraft Corporation

SAN DIEGO · CALIFORNIA

PAA Maintains Atlantic, Pacific Services PANAGRA Adds Fifth Mail Schedule

Pan American Airways is operating full capacity on both the Atlantic and Pacific, despite war conditions, which interrupted service for a brief period following Dec. 7. Flights were trebled in the first two weeks of the war, and are now faster and more frequent. Flight captains and crews learn by heart every detail of their trip, with no single course followed, and no two flights the same. Departure times, though guarded by secrecy, are varied. This, with changing weather, speeds, altitudes, and course, makes it impossible for an outsider to determine a plane's route.

PAA flys "blacked-out"on all sea routes—no lights, radio, position reports, weather broadcasts, or arrival or departure messages. Each ship is equipped to proceed on orders which would take her across any of the seven seas. PAA is putting into practice lessons learned by its Chinese lines which have survived four years of warfare.

American and Chinese pilots have learned to make use of dark nights and weather, of flying blacked-out through radio silence, moving from cloud mass to cloud mass.

A new air mail service, the fifth down the west coast of South America, is now in operation by Pan American Grace Airways, making five schedules each week over the 4,416-mi. route, between the Canal Zone and Buenos Aires, Argentina.

On one trip over the Indian Ocean a tool used for servicing the engines was broken. The nearest duplicate being 10,000 miles away, the pilot sighted an allied warship, set the plane down on the water abroadside, turned out the wrench on the ship's lathes, climbed back in and flew off, in one hour.

Transport Gets A-1-J On Maintenance Parts

Washington (AVIATION Bureau) — Further evidence of the airlines' importance to conduct of the war is the War Production Board's increase of preference rating on operation and maintenance materials from A-3 to A-1-j. The A-3 rating was established by Order P-47 Sept. 12, 1941. The higher rating was ordered in an amendment to P-47 by J. S. Knowlson, director of Industry Operations.

Other provisions of P-47 remain in effect: carriers and suppliers using the higher rating must furnish a copy of the amendment to each supplier to whom the original order was furnished. The rating covers materials necessary for new airplanes and for upkeep of planes and ground equipment.

No Instrument Landing Till After the War

Inquiry indicates that there will be no scheduled use of instrument landing equipment till one or two years after the war ends.

Eastern Air Lines recently called attention to a loss of $11,000,000 handed back to its canceled passengers since January 1936. Eastern said this amount was not more than 20 percent of the cost of "stacking" during that period. Company stated its opinion that neither the airlines, singly or as a body, or the CAA, had effectively championed the instrument landing system, which would have permitted many more trips to be made.

The authority's officials say they are sympathetic with the airlines in this matter. They point to the long controversies which delayed development in recent years—which at last was ended by the President, who demanded settlement on one system. They say also that very little further production of equipment can be had till the war ends. Then it will take a year or two or three to train pilots and get into operation.

Eight installations are under contract with IT&T and the same company has bid on ten more. The Indianapolis station has operated for months experimentally, and the one at Washington is two-thirds completed.

Safety Award Winners

Certificates of award for safety were presented at a luncheon, March 6, to climax the 1942 annual convention of the National Safety Council Awards are as follows: Panagra flew 23,805,139 passenger and 2,667,431 route miles without accident; Western Division of Pan American Airways System, 30,489,737 passenger and 3,386,768 route miles; Compania Mexicana de Aviacion 1,948,075 route and 18,971,780 passenger miles; Avianca, 12,-973,493 passenger and 2,083,-106 route miles; Cubana 3,567,-391 passenger and 747,620 route miles.

A certificate of safe operation was awarded to Northeast Airlines, for safe operation during 1941. Northeast has operated more than 25 million passenger miles during its entire operating history without a passenger fatality.

Braniff Airways received its third safety award for operating 103,603,136 passenger miles without a passenger or crew fatality for 1941.

Here's a brand new job for girls in aviation. Vera M. D. Covell, 23-year-old New York girl, directs Clipper landings and takeoffs by radio at LaGuardia Field.

Airlines Can Use AAF Alternate Ports

Commercial airlines are permitted to use Air Force bases as alternate ports when weather or other emergency conditions prevail, making scheduled airline terminal ports unsafe, under authority of an Army order recently issued.

Airlines must obtain permission of the AAF base to be used and file a flight plan prior to departure; estimated time of arrival must be given; the pilot must be apprised of all traffic, communications and other conditions at the AAF base he intends to use; the commandant must be notified if the commercial plane changes its plan and goes elsewhere; the United States Government will assume no responsibility or liability for any failures.

DIO Interprets P-47

The Division of Industry Operations issued Interpretation No. 1 of Preference Rating Order P-47, making it clear that the rating for airlines includes maintenance equipment, ground radios, tools and essential office facilities, as well as parts of planes. Some suppliers had been refusing deliveries to airlines, to whom the benefit of the order has been extended, of any material not essential to flight.

TWA Trains Women

Transcontinental & Western Air, Inc., has started a special school at its Kansas City base to train young women as passenger agents to replace men called to service. Women already in their employ are selected first to fill in behind ticket counters, but men will continue to supervise loading and unloading of planes. TWA also drops the requirement that a hostess must be a registered nurse.

Service Insignias Used On WAL Timetables

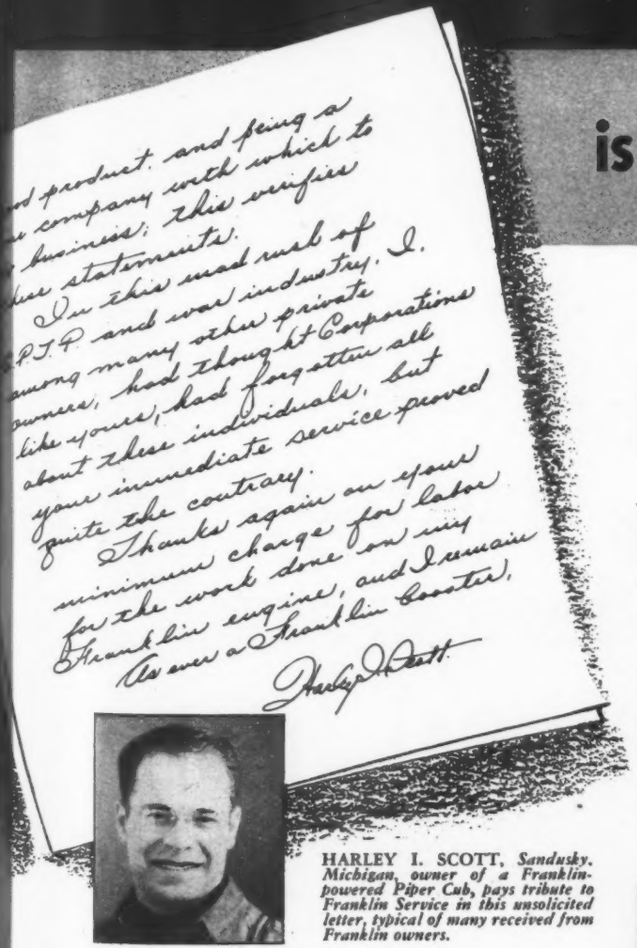
Western Air Lines, sensing public interest in U. S. Armed Forces' service insignia, this month decorated its new timetable cover with 75 insignias covering the Army, Navy, Marines and Air Forces. They are arranged in sequence of rank, and branch of service.

In these times especially . . .

Franklin

Plus SERVICE

is appreciated More than Ever


product and being a
company with which to
business; this verifies
statements.
In this mad rush of
P.T.P. and war industry, I.
among many other private
owners, had thought Corporations
like yours, had forgotten all
about these individuals, but
your immediate service proved
quite the contrary.
Thanks again on your
minimum charge for labor
for the work done on my
Franklin engine, and I remain
As ever a Franklin booster,

HARLEY I. SCOTT, *Sandusky, Michigan, owner of a Franklin-powered Piper Cub, pays tribute to Franklin Service in this unsolicited letter, typical of many received from Franklin owners.*

Today, periodic engine check-up and overhaul becomes increasingly important as planes and parts are called upon to do heavier C.P.T. and C.A.P. duty. But extended demands on Franklin service facilities are being more than met, in traditional Franklin style.

Franklin service is fast, economical and exact. Franklin service stations, strategically located throughout the hemisphere, have the parts and equipment to serve you quickly with emergency overhaul or parts replacement. Franklin design, standardized to provide interchangeability of parts, makes for readier availability of parts and easier replacement.

And when factory overhaul becomes necessary, you can bank on Franklin's 42 years of air-cooled engine experience to give you the same speed and attention praised by Pilot-owner Harley Scott.

Write for the location of your nearest Franklin Service Station.

Franklin

Aircooled MOTORS CORP.

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The popularity of Berry Brothers Aircraft Finishing Materials has increased over the years, to the point where it now represents three-out-of-four preference. Three out of four planes are finished with Berry Brothers materials. Production of quality aircraft finishes helps to "Keep 'em Flying."

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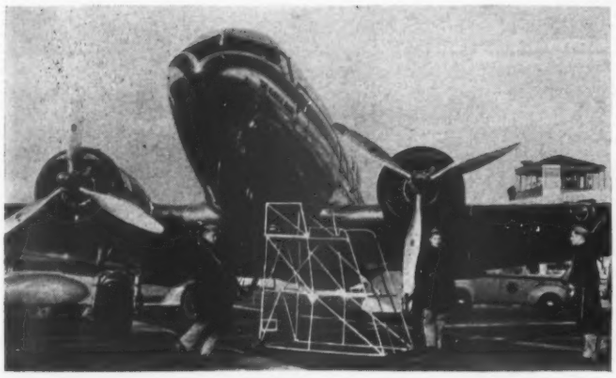
LET'S GO! U.S.A. KEEP 'EM FLYING!

BERRYLOID

AIRCRAFT FINISHES



Wide World

At the Chicago municipal airport, one of the busiest in the country, the State Reserve Militia stands guard day and night to safeguard the nation's vital air transport system from possible sabotage.

on a background of red and white stripes, similar to the U. S. flag. The company's name appears in a blue field. Initial demand indicated the original order of 65,000 will soon be exhausted and reprints will be needed. Traffic on the line, for January, showed a 48.25 percent increase over the same month of 1941. Mail and express shipments showed a similar increase.

Airport Grass Research

Dr. John Monteith, Jr., director of the Greens Section of the U.S. Golf Association and in recent years a collaborator at the U. S. Bureau of Plant Industry, has done research on the growing of grass which is interesting to airport operators. Imported grass types which Dr. Monteith has grown successfully in Washington are adapted for airport use and for defense housing purposes. Years ago Germany sent an observer over to see what America was doing in grass culture.

One Oriental type, known as "zoysia," forms a heavy resistant ground cover and grows only 6 in. high, thus minimizing the need for mowing. Although seed for unusual types are not yet available in quantity, Dr. Monteith's studies have indicated practical methods for making the most of ordinary grass on which much money is wasted with poor results unless proper techniques are followed. Attention is called to this information by NAA and by Rep. Jennings Randolph.

TRANSPORT DOINGS

TWA in its annual report disclosed net operating losses for 1941 of $487,613; reduction in air mail revenues, increased costs of labor, materials and supplies, higher taxes and insufficient equipment to accommodate overflow passenger loads contributed to the deficit comparable to a loss of $97,972 for '40.

Continental Air carried a total of 202 passengers as the result of a "First Rider" contest conducted among the employees.

Railway Express Agency had 1,306,629 air express shipments in 1941, an increase of 21.2 percent over '40; weight was up 46 per cent to 5,620 tons; average weight per shipment increased 1½ to 8.6 lb.

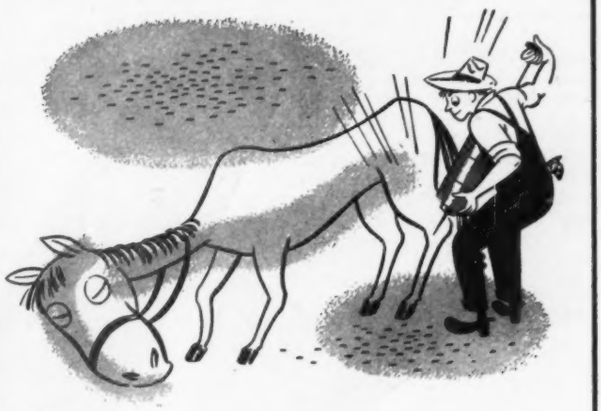
Trans-Canada, two years ago, employed practically no women stewardesses, but now this line has nearly 100 employed on a temporary basis only, protecting those who have gone into service. Company is now manufacturing its own seats after being tested and approved by the Department of Transport.

American Airlines will no longer require that applicants for the position of stewardess be registered nurses.

Northwest Airlines prohibits use of cameras aboard company planes for the duration of the war, after an agreement with the War Department. Company explained they are operating 63 seats a day between the Twin Cities and the west coast and 126 seats a day between the Twin Cities and Chicago. So far priority has interfered very little with the normal flow of traffic and there are plenty of seats for the traveler flying on business or pleasure.

Penn-Central observed the first anniversary of the Pittsburgh-Birmingham passenger air route, inaugurated a year ago. Programs were held in Pittsburgh, Morgantown and Charleston, W. Va., Tri-Cities, Knoxville and Chattanooga, Tenn., and Birmingham. During the first year of operation, more than 20,000 revenue passengers have been carried over the 682 mi. route that links the two largest steel centers in the U. S.

United Air Lines' Los Angeles to Washington service has been increased to four flights daily, to meet the increasing demand for reservations, it was announced Feb. 24. Under the new schedules, passengers and cargo leaving Los Angeles at 1 p. m. can be in Washington at 9:30 a. m., S. R. Newman, United's district traffic manager stated.



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Springs fabricated from the correct metal can add substantially to the life of your product. That is why material analysis is such an important function at Muehlhausen.

Metals are checked and rechecked with the help of delicate laboratory mechanisms. No company pursues more exacting experiments with metal—none possesses better or more modern laboratory equipment.

This supersensitive balance is used to determine the proper percentage of the basic elements in spring metal. Measuring in 1/10,000 of a gram, it allows comparison of the component parts of the metal with predetermined standards.

Feel free to check with Muehlhausen on any phase of spring design. There's no obligation—and you may very well add tremendously to the life of your product.

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EVERY TYPE AND SIZE

Buccaneer Base

MORE than a century ago a hardy band of buccaneers, led by Jean Lafitte, stood with the ragged army of Andrew Jackson at New Orleans to win a battle for the existence of the young republic. Today a modern sea-raider, the far ranging Brewster Buccaneer Dive Bomber, is playing an important role in another fight against aggression. These sleek, swift and powerful planes, now in production, will soon be carrier-based with the battle line of the United States Navy, will augment the range and striking force of our ever-growing fleet. Rolling off the line in increasing numbers, today's Buccaneers will help America and her allies achieve their all-important goal—an enduring mastery of the air.

Brewster

FOR LASTING MASTERY OF THE AIR

United Aircraft Corp. relinquished $10,000,000 of its revenue from contracts with the United States Navy in 1941 through its desire to avoid excess profits resulting from an accelerating volume of war production. With one exception all contracts of the company are on a fixed-price basis. A reserve of $10,000,000 also was set aside in 1941 to meet future expenses incident to "going out" of war production **later on.**

Several other aircraft companies have voluntarily reduced the fees in their war contracts with the government which legally can run as high as seven percent before taxes. **Douglas Aircraft,** most of whose business will be under fixed-fee contracts, has voluntarily reduced its fee in several major awards from six to five percent. The new fee scale affects at least one company's backlog of unfilled orders. Application of income taxes to these fees will reduce net income to Douglas more than half, according to company officials. **North American Aviation also has cut prices voluntarily on unexpired contracts.**

Eugene Wilson, president of United Aircraft, in his 1941 report to shareholders gave statistics to show how rapidly foreign contracts of his company, and incidentally those of all the aircraft industry, are being completed and operations centered on American war contracts. United Aircraft's shipments last year were 58 percent for the account of the United States government as against 23 percent in 1940. This year it is estimated the proportion going to the government will reach 80 to 90 percent. Profits on government contracts amounted to five percent last year, against seven percent in 1940, and "indications for 1942 are for a further substantial reduction in the rate of profit on sales to the government."

Eastern Air Lines directors have approved the purchase of five new-type DC-4's and five DC-3 transport planes at a cost of $3,500,000. The company already had 17 freight and passenger planes on order at a cost of $3,000,000.

Rohr Aircraft Co., San Diego, Calif., paid a 25¢ per share dividend on March 10, to all capital stock of record Feb. 28. Directors also named Frank H. Nottbusch, general counsel, to the Board to succeed E. P. Campbell, and elected Guy M. Harrington secretary and assistant treasurer.

Bendix Aircraft, largest American aircraft parts and accessory concern, has a new president, Ernest R. Breech, who resigned a General Motors Corp. vice-presidency to succeed Vincent Bendix in the new post. Mr. Bendix becomes chairman of the board. In a statement following his election Mr. Breech said that the number of Bendix employees had increased from 10,000 to 40,000 in three years and would total up to 65,000 or more by 1943. In the same period Bendix has established upwards of 300 new subcontractors. General Motors holds around 20 percent of the outstanding stock of the Bendix company.

Douglas Aircraft issued its annual report to shareholders showing sales for the year ended November 30, 1941, were triple those of the preceding year while earnings also went up to a new high. Donald W. Douglas, president, explained in the report that 88 percent of the $30.29 profit on each share of stock came from sales to foreign governments and added that the "old definition of profit as tangible financial benefit gives way before war industry conditions, which make earnings an added resource for serving the nation."

Stock of one of the airlines figured in the largest over-counter offering ever made in Wall Street last month when a block 93,769 shares of American Airlines, involving a total of $3,703,875 (the stock being priced at $39.50 a share), was sold in a single day. The commissions alone amounted to more than $126,000. The offering was made by Emanuel & Co., Lehman Bros., and associates.

Ryan Aeronautical Co., San Diego, Calif., notified stockholders Feb. 21, of a 25 cents per share dividend, payable March 25, as part of a new policy that included switching from the calendar to an October fiscal year basis. For the fiscal year ending Oct. 31, 1941, actually only 10 months, net profits were $669,603.44 after all charges. Taxes totaled $1,602,669.01. For the previous full year, the net profit was $358,343.67 and taxes were $320,161.13. Outstanding are 439,193 shares of stock. The booklet containing the annual report was illustrated with photographs of the Ryan plant and products.

Some interesting data on the future of air travel was supplied Chicago bankers at a recent luncheon by W. A. Patterson, president of United Air Lines. Patterson predicted that the present 19 airlines in the United States would be consolidated into six or seven after the war by mergers and other means. He noted that small lines would have diffi-

★ ★ ★ By RAYMOND HOADLEY ★ ★ ★

DEFENSE AUTHORITIES state that the aircraft war production program is fully up to schedule. This means, if things continue to go well, that the output of the aircraft manufacturing industry this year will run between 5 and 6 billion dollars as compared with the record delivery volume of 1.6 dollars in 1941. To enable one to comprehend the vast size that the aircraft industry is now taking, it is pertinent to point out that one of the biggest of the nation's peacetime industries—the mass-production automobile industry—considered it a banner year when the sale of motor cars ran in the neighborhood of 3 billion dollars. What does this revolution mean in terms of individual companies? In the case of Bendix Aviation Corp., for example, it means that sales, which had skyrocketed from $42,000,000 in 1939 to $156,000,000 in 1941, probably will amount to more than $500,000,000 in 1942 and run up to the breath-taking total of $1,000,000,000 or better in 1943. So it will be with most companies in the industry. But the almost fantastic gains in dollar sales that lie directly ahead do not mean that earnings will show a corresponding increase. Sharply mounting taxes and the tendency on the part of the industry to voluntarily cut the price of war planes probably will stabilize earning power at or perhaps slightly under the 1941 levels. Preliminary indications are that the conservative dividend policies followed by most concerns making disbursements to their stockholders last year can be maintained in 1942. Working capital requirements continue to increase and in most instances Wall Street expects that this demand will be met largely though plowing profits back into the companies or through progress payments from the United States government rather than through new financing.

★ ★ ★ ★ ★ ★ ★ ★

Current Earnings Reports

Company	Period	Net Profits 1941	Net Profits 1940	Profits Per Share 1941	Profits Per Share 1940	Sales 1941	Sales 1940
Aero Supply	12 mos. Dec. 31	$805,796	$554,257	$1.90	$1.29	$7,934,529	$3,797,671
American Airlines	" " " "	2,473,160	1,858,550	3.93	4.77	26,262,657	20,689,618
Aviation Corp	" " Nov. 30	2,454,142	88,350	0.42	0.02	18,680,639	5,235,439
Bellanca Aircraft	" " Dec. 31	L 151,954	L 168,841	.....	.....	.....	.....
Breese Corp	" " " "	1,548,747	801,235	4.76	2.48	.....	.....
Consolidated	11 " Nov. 30	8,024,882	.....	6.22	.....	95,529,051	9,349,550
Douglas	12 " " "	18,176,690	10,831,971	30.29	18.05	180,940,110	60,970,774
Ex-Cell-O Corp	11 " " "	2,480,678	.....	6.22	.....	.....	.....
Irving Air Chute	12 " Dec. 31	371,537	411,136	1.88	2.08	.....	.....
No. American Aviation	3 " " "	2,738,543	2,362,798	0.80	0.69	35,210,985	12,557,139
Roosevelt Field	12 " " "	96,656	79,782	0.32	0.27	.....	.....
Ryan Aeronautical	10 " Oct. "	669,602	.....	1.52	.....	.....	.....
Square D Co.	12 " Dec. "	3,104,343	2,023,203	7.13	4.56	14,035,096	6,324,666
T.W.A.	12 " " "	L 487,613	L 97,972	.....	.....	14,064,260	11,572,221
United Aircraft	12 " " "	16,721,380	15,443,057	6.29	5.81	307,389,494	126,350,128
United Aircraft Products	11 " Nov. 30	496,970	.....	1.85	.....	.....	.....

L — Loss.

culty keeping pace with technical and other developments in air transportation after the war. On the other hand he asserted that from six to nine American and European airlines would begin trans-Atlantic service soon after the war.

Studebaker Corp. expects that sales this year will run at about three times the level prevailing during its best recent years. One of this automotive concern's main war tasks is the production of Wright aircraft engines.

Airline travel is running as much as 25 percent ahead of the corresponding early months of 1941 in many cases. Better weather and an increase in war traffic are mainly responsible for the rise which should enable the air transport companies to report much better operating results for the first quarter of 1942 than a year ago. The big losses some of the lines showed in the winter months of 1941 were not entirely offset later in the year. W. A. Patterson, head of United Air Lines, predicts record traffic in 1942 while Jack Frye, president of TWA, recently told his stockholders that the air traffic peak this year would be limited only by equipment and personnel.

Electric Auto-Lite Company has purchased an airport at Toledo and is constructing buildings there preparatory to production of aeronautical equipment. The company expects to continue engineering experiments and production in the aircraft industry after the war. No federal aid is to be asked in the construction of the new plant which will cost around $3,000,000.

North American Aviation is running well ahead of the War Department schedule at its new Kansas City bomber assembly plant. March output, it is learned, will be several times greater than originally scheduled. The company's percentage of gross sales carried to net profit in the December, 1941 quarter was 8 percent, contrasted with 18 percent in the similar period the previous year.

Packard Motor Co. expects to reach maximum output on its Rolls airplane engine contracts later this year. Both inventories and payrolls of the Rolls contracts are financed out of a revolving fund provided by the American and British governments.

Air express shipments passed the 1,300,000 mark in 1941, the largest annual total in the 14-year history of the service. Domestic air express revenue for the year exceeded $4,275,000 while the 1,306,629 shipments showed an increase of 21 percent over 1940.

Aviation Corp. reports that blacklogs of war orders on the books of the various companies in its group, which include Vultee Aircraft, Lycoming and Consolidated Aircraft, are among the largest in the country. Aviation Corp. now owns 75 percent of Vultee's common stock and has large holdings also in New York Shipbuilding and Auburn Central Mfg. Co.

There is a growing tendency among aviation companies to change their fiscal years from the calendar year ending December 31 to September 30. Consolidated Aircraft and North American Aviation are the latest to join Bendix Aviation in this movement. Douglas Aircraft and Vultee have closed their books at the end of November for several years.

Here and There . . . Bell Aircraft has listed its 354,900 common shares on the New York Stock Exchange. The stock was formerly traded in on the curb . . . Monthly dollar sales of **Continental Motors** now run much higher than the former yearly rate . . . **Bendix Aviation** is reported to have utilized its $10,000,000 line of bank credit to meet increased working capital needs . . . Taxes took $1.40 for every $1 earned by **Douglas Aircraft** last year while **Consolidated Aircraft** expended $2.64 for every $1 of net income retained . . . **Glenn L. Martin** is in the final stages of its expansion program . . . **Square D Co.** spent nearly $1,000,000 on new plants and equipment in 1941 . . . War orders will enable **Borg Warner** to top 1941 sales this year despite almost complete loss of its civilian markets . . . **Pioneer Parachute Co.** of Hartford is expanding its facilities and organizing a new subsidiary, Atlantic Parachute Co. . . . **Brewster Aeronautical Corp.** has been named in a $10,000,000 lawsuit . . . **American Airlines** has organized a new subsidiary to handle airport restaurant and airline catering . . . Eighty transport airplanes have been allocated to the airlines for delivery in the second half of this year. . . . J. Paul Getty, head of the Getty oil interests in California has been elected president of **Spartan Aircraft Co.** to succeed W. G. Skelly, president of Skelly Oil Co. . . . D.L. Zacharias has been elected treasurer of **Taylorcraft Aviation Corp.** . . . **Vultee** and **Northrop** are in production on the Vultee dive bomber . . . Alvin P. Adams has left Seaboard Airways to become president of **Duramold Aircraft Corp. Airlines** have been assigned a higher preference rating—A-1-J—to assist them in obtaining materials for new aircraft and for the upkeep of planes and airfields, the WPB announced.

On the Raw Materials Front

A SCARCITY IN ALUMINUM FORGINGS, along with a continued tight situation in several types of accessories constitutes the main barrier right now toward achieving the 1942 war production goal of 60,000 planes. A short time ago a chief worry was propellers but that particular hitch has smoothed out although there is unlikely to be an entirely ample supply of spares at any stage of the program.

The unexpected need of Russia for American aluminum has curtailed somewhat the domestic supply but the bottleneck so far has been in the white metal forgings instead of aluminum ingot. To prepare for future needs as the warplane production program accelerates, however, a new aluminum expansion program is coming off the drawing boards, the third in less than a year. This new program will boost production to 2,100 million pounds and, including the contemplated importation of 450 million pounds from Canada, will call for the future annual output of nearly 2,600 million pounds of aluminum.

Production of this light metal in 1941 amounted to 615 million pounds, of which 602 million pounds were supplied by the Aluminum Company of America and approximately 13 million pounds by Reynolds Metals Company. Output this year is estimated at around one billion pounds and by the year-end it is expected to reach a rate of 1,450 million pounds.

In order to produce the 640 million pounds of aluminum called for in the new government program it will be necessary to mine an additional million and a half tons of bauxite; to convert this into 1,300 million pounds of aluminum; to erect new plants for the manufacture of carbon electrodes; to supply all the electrolytic plants; to provide facilities for converting about half the aluminum produced into sheet metal; to construct extrusion plants, casting and forging plants and to build plants for the production of synthetic cryolite and aluminum fluoride.

All this construction, defense officials estimate, will require some 250,000 tons of steel; about 1,000,000 kilowatts of electricity constantly available for operation; the use of 200,000 tons of petroleum coke annually; 100,000 tons of soda ash, 60,000 tons of sulphuric acid, 420,000,000 tons of fibre cloth and a great variety of other products.

The coming need for all these materials will accentuate the shortage of steel, electric power and soda ash. The latter is extensively used by the glass industry whose production also has been vastly expanded by the curtailment in the use of tin for containers.

The new aluminum plants will be located where the greatest sources of electric power from existing facilities can be utilized. The major sources of power are in the metropolitan areas, which means that many of the new installations may necessarily have to be built in such vulnerable coast areas as Boston, New York, Philadelphia, etc.

In magnesium too, a new expansion program is contemplated that would have seemed almost fantastic a year ago. Under the new plan, production of this lightest of all metals will be hiked from the previous 1942 goal of 400 million pounds to 725 million pounds. Five years ago this metal was just out of the experimental stage with an annual output of six million pounds a year. Current output, practically all of which is accounted for by Dow Chemical Company, runs about 60 million pounds a month. Dow will continue to carry the chief burden of producing this vital aircraft and incendiary bomb metal although Union Carbide & Carbon, Ford Motor Company, Matheison Alkali and a number of other companies are building facilities to produce magnesium.

Speaking of Responsibility . . .

The rigid standard of American Aviation is the same in peace or war: UNFAILING PERFORMANCE. In warplane and transport, Dumore fractional horsepower motors respond instantaneously . . . assure *extra hours* of dependable power, far beyond normal operation requirements. That's why specifically designed Dumore aviation motors are selected to operate anti-icer pumps, cowl and wing flaps, oil cooler exit flaps, rudder tabs, trim tabs, windshield defrosters, ammunition booster units and other vital controls. Consult with Dumore engineers about your particular power problem, without obligation.

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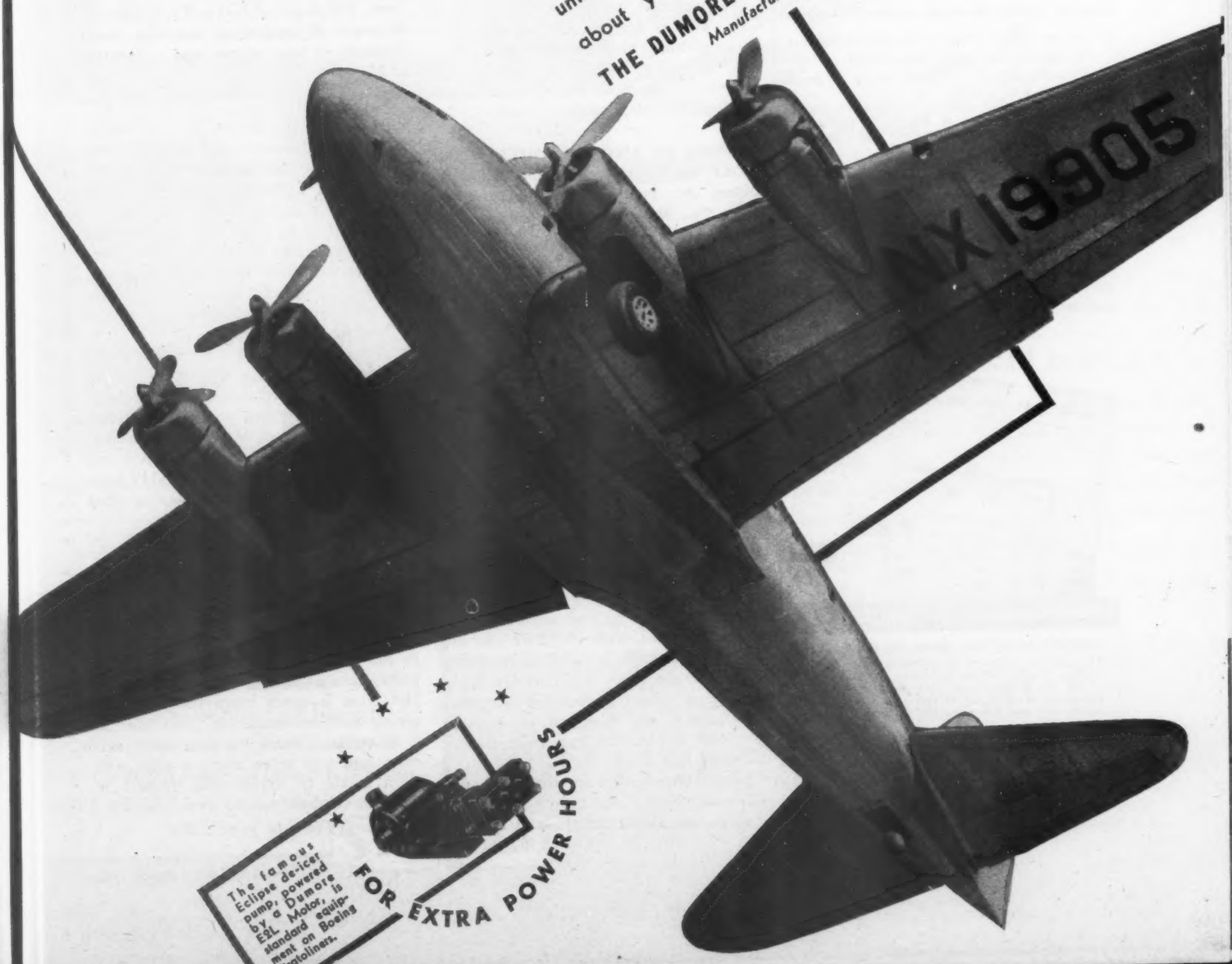
Manufacturers of Fractional Horsepower Control Motors



The famous Eclipse de-icer pump, powered by a Dumore ESL Motor, is standard equipment on Boeing Stratoliners.
FOR EXTRA POWER HOURS

How to Get AVIATION SUBCONTRACT WORK

The aircraft industry is seeking additional hundreds of subcontractors to speed the world's largest wartime airplane program

With so many manufacturers from other fields signing up for the production battle, there is an urgent need for a *quick way* to bring together the prime contractor and your organization—to help him accelerate production.

To secure favorable consideration, you must do a selling job aimed at the prime contractors. Instead of waiting for them to make the first move, command their attention by advertising your plant facilities and equipment in *Aviation Magazine's* new SUBCONTRACTORS SECTION.

This new service to Subcontractors provides an economical, effective and faster means of establishing and maintaining contact between you—the seller, and the prime contractors—who are the buyers—to speed the process of selecting specific service and equipment.

Every month, in *Aviation's* central market-place—the SUBCONTRACTORS SECTION—you may profitably bring your facilities and experience directly to the attention of prime contractors . . . at a reasonable cost. Today *Aviation* is read by the identical individuals in the aviation industry you must sell to get your share of subcontract work.

Tell your story to the men who must be sold by using the special advertising section in Aviation

. . . to offer your facilities to the aircraft industry

. . . to take on additional contract work

. . . to assure continuity of work during the emergency

. . . to make certain that the thousands of aircraft executives and experts in charge of production know about your plant, equipment and experience in related work

. . . to present your production story to the hard-to-reach men whose business is wartime output

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You can speed your offer of help to the key men of American aviation quickest through the advertising pages of the special SUBCONTRACTORS SECTION in Aviation . . . the industry's No. 1 business magazine.

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Recent Books

COMMERCIAL AIR TRANSPORTATION, *by John H. Frederick, Ph.D., Published by Richard D. Irwin, Inc., Chicago; 500 pages; 104 graphs, tables, and illustrations; indexed; $4.00.*

Because of time-saving speed, air transportation, in the 15 years of its existence, has become invaluable to commerce and national defense. It has grown with staggering rapidity. Yet the possibilities of its further development challenge the imagination.

Accepting the challenge, Mr. Frederick has collected material from extensive sources and carefully arranged it in the book for the benefit of the industry, its students and teachers, and its public users, present and future. Himself a professor of transportation and industry in the school of business administration at the University of Texas, he has called upon his knowledge and imagination in analyzing existing conditions and looking into the future.

A glimpse at selected topics from the book: airport development; adequacy of feeder airlines; airline equipment, operation, financing, selling, promoting; air express development and its managerial problems; airmail rates.

HOW TO DO AIRCRAFT SHEET METAL WORK, *by Carl Norcross and James D. Quinn, Jr. Published by McGraw-Hill Book Co., New York and London. 285 pages, $2.20.*

This book is primarily for those who want to know how-to-do-it. As such it presents the fundamentals of aircraft sheetmetal processes in clear, simple language without the use of technical terms or formulas. Moreover, the reader is told *why* as well as *how* to do it, and the drawings and other illustrations are calculated to aid considerably in this purpose.

The first chapter introduces the reader to blueprint reading, which is necessary as the sheetmetal mechanic must understand the engineer's language and directions in order to make progress in his work. The book provides reproductions of actual blueprints from which the reader is taught and to which he can constantly refer from the text. At the end of the chapter is a list of questions relating to the blueprints covered. Each chapter is similarly provided by questions which are designed to indicate how well the student has mastered the contents.

Shop Mathematics are treated in the following chapter, the purpose of which is to review fundamentals, and may be skipped by those who are already acquainted with the subject.

Thereafter, sheetmetal work is dealt with directly, beginning with Working Properties and Standards of Materials, and ending with Shop Projects. The five projects of this last chapter require all the basic sheetmetal skills and the use of the common sheetmetal tools, and from 160 to 175 hours of shopwork are necessary to complete them in a satisfactory manner.

The authors, who also wrote *The Aviation Mechanic,* visited nearly all the aircraft factories in the country to gather material for this book, and have attempted to present a work which will train men for aircraft work in a way that has been specified by military air services and by the aircraft industry. We believe they have done a thorough, simply-stated job.

YOUTH MUST FLY, *by E. F. McDonald, Jr. Published by Harper & Brothers, New York. 136 pages of text and illustrations, 78 pages of appendices, including specifications of four gliders and sailplanes, $2.50.*

Soaring enthusiasts will welcome this with open arms; if only half the things the author argues and pleads for are realized the youngsters of America, to whom it is dedicated, may well adopt him as their patron saint.

Here is a fervent, but at the same time logical, plea for the 'teen age boys of America, those who have outgrown model building and flying but who are not yet of age or financial circumstances to take up power flying.

The book explains the rudiments of gliding and soaring, but its principal and well developed theme is the problem of getting American youth into gliders now, as a means of developing pilot material for the future need of civil and military aviation. Mr. McDonald's book should do much toward solving that problem.

CLOUDS, AIR AND WIND, *by Eric Sloane. Published by the Devin-Adair Co., New York City. Illustrated, 76 pages, $2.50.*

Eric Sloane has done a masterful job in his interpretation of meteorological phenomena as seen by the airplane pilot. His book is much more than a sightseeing tour, however. It ranks high as a first-class primer on a complex science, and will serve many a pilot well as a guide to flying with respect to weather conditions.

(*Turn to page 227*)

THE BELL AIRACOBRA P-39 in a fighting mood. The Airacobra uses many Synthane parts in the plane and its Curtiss Electric Propeller.

LB. SAVED HERE—Automatic perature regulation motor for cial aircraft heating system. making the motor case of nthane, Barber-Colman saves r one-half pound per unit.

SPERRY 800,000,000 Beam Candlepower Searchlight. Many of the parts for this giant beam are machined from Synthane Bakelite-laminated materials.

Lightweight

Synthane

helps keep 'em flying — faster, farther and higher

EVERY ounce counts "upstairs"—means longer, higher, faster flight or more armament. The use of Synthane in America's fighters and bombers saves precious ounces, for Synthane weighs only half as much as aluminum.

You'll find Synthane in hundreds of structural, electrical-insulating and corrosion-resisting parts—in planes and accessories. Not only does this versatile material save weight, but time in production since it is easier to machine than most metals. That's why Synthane supplies so many manufacturers of planes and accessories.

SYNTHANE CORPORATION, OAKS, PENNA.

THE AVIATION INDUSTRY *OK's* SYNTHANE

Bakelite-laminated for

LIGHT WEIGHT with Structural Strength
LIGHT WEIGHT with Corrosion Resistance
LIGHT WEIGHT with High Dielectric Strength
LIGHT WEIGHT with Ease of Machining

SYNTHANE

Bakelite — laminated

SYNTHANE TECHNICAL PLASTICS

SHEETS • RODS • TUBES • FABRICATED PARTS • SILENT STABILIZED GEAR MATERIAL

Materials to remember, specify and use for aircraft parts

Healthy Workers

(*Continued from page 56*)

exactly the effect food has on physical fitness and on industrial production is now being made at the Lockheed Aircraft Corporation plant in southern California. Lockheed has turned over part of its manpower for a nutrition study by scientists of the Committee on Nutrition in Industry of the National Research Council. Preceding the test, a preliminary study of workers' diets is being made. Now in progress, it already provides convincing evidence that "workers don't eat right." It's been found, so far, that 69 percent are not eating enough Vitamin A—that vitamin which helps them to see well—30 percent don't get sufficient B_1 which gives them the "will-to-fight," American for morale—and 30 percent lack Vitamin C.

Evidence to determine how these dietary omissions affect production will be gathered over a two-year period. Out of 1,000 workers participating in the experiment, 500 will be given daily rations of vitamins and minerals. Medical histories, absenteeism and work output records will be carefully kept.

If, as observers expect, the men receiving vitamins exhibit better health and efficiency than those not getting vitamins, industries will be advised to hire dieticians who will plan nutritious, balanced meals for workers in company cafeterias. They will direct educational programs for workers and workers' wives. In Connecticut nutritionists have distributed leaflets and in one plant held a "nutrition quiz" meeting for workers. A vast program for teaching factory workers' wives how to serve proper food to their menfolks is now being planned by the Industrial Council of the National Association of Manufacturers. House organs, motion pictures, sound-slide films, and lectures on health subjects may also be utilized.

HIGH COST OF COLDS

As a result of such education, it is hoped, vitamins as well as minerals and other essential food elements will be supplied naturally and economically through food. Authorities believe physical resistance will accordingly be strengthened so that workers will be more able to combat general illnesses, which today cost industry fifteen times more hours lost than do industrial accidents—specifically, about 190,000,000 work hours. Prosaic colds, which might beset any citizen of a community, alone present industry with a bill for $450,000,000 each year.

For specific disturbances, authorities conceive a widespread use of vitamin concentrates to supplement the diet. Such a supplement, proving particularly useful in some parts of the aircraft industry, might be capsules containing Vitamin C. Investigators have found that after treatment with Vitamin C workers who had shown marked symptoms of lead poisoning exhibit a striking gain in "vigor, cheerfulness, blood picture, color of skin and ability to sleep." The routine administration of 50 milligrams of Vitamin C was therefore recommended. These vitamins may be most conveniently taken, as are salt tablets by workers exposed to great heat, from dispensers holding paper cups. A vitamin capsule is placed in each cup, and the cup is sanitarily disposed of after use.

The need for proper feeding facilities has been emphasized by Britain's Labor Minister Ernest Bevin. After a long study of absenteeism he told Parliament that one of its remedial causes is "defective feeding arrangements at the works." Because many American aircraft manufacturing plants are new, aircraft officials have been especially well able to forestall such complaints. Sanitary, modern and convenient feeding practices and equipment are being provided. Many studies have shown that supplemental feedings, consisting of such drinks as a milk and banana mix, increase a worker's output.

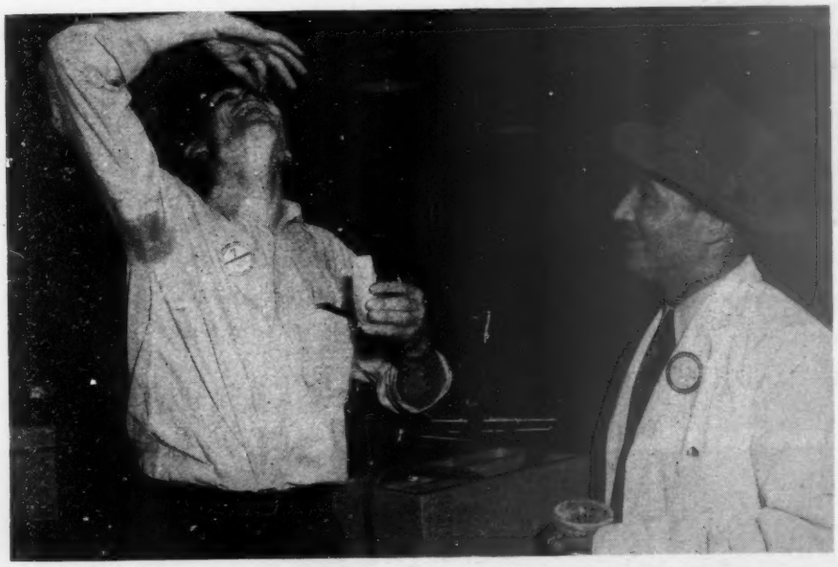
FEEDING UNITS

To provide these in-between snacks, as well as regular lunches, mobile feeding units are widely used in plants. Through the use of paper cups and containers with such units, a variety of hot and cold nutritious foods can be deftly and quietly dispensed to workers. Coffee is carried in a stainless steel insulated tank and dispensed to order in unwaxed paper cups. Milk is served in the less expensive waxed cups. Such he-man food as meat pies, hot soup, chili, baked beans, spaghetti and macaroni are baked right in paper containers in a central kitchen and carried in a hot insulated compartment on the cart. The food is conveniently eaten from the container in which it is baked. Good-for-you desserts such as Tapioca, Brown Betty and baked apples may also be served in paper containers so workers need not satisfy their yen for "sweets" by consuming unwholesome quantities of candy.

Paper cups and containers, easily stacked on these wagons, take little space. Each worker is assured of having his food served in a sanitary cup or container which has been used by no one else and which is discarded when he is through with it. Rattling of crockery as the wagon meanders through the plant, as well as during service of food, is eliminated—an important point since many workers are adversely affected by unusual or unnecessary noise. The dangers of accidents or sabotage from bottles or glassware in the premises is averted.

ROLLING KITCHENS SAVE TIME

In one California aircraft plant, employees are fed exclusively from these rolling wagons, and in others, cafeterias are operated with mobile units serving employees in distant parts of huge plants. These workers thereby are assured of being fed at regular hours and without loss of time in getting to and returning from eating places. In



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one plant which has eight outdoor eating places serviced by canteens, each of 12 [illegible] workers is saved a ten-minute walk to an eating place. Time thus saved, the management has estimated, amounts to 250 work days a year. Where there are cafeterias paper service is also extensively used, for it meets the highest sanitary standards, thus affording protection to workers from infections that might be spread by inadequately washed glasses. It also eliminates dish washing at a time when labor, disinfectants and machine replacement parts are scarce. The experience of the Los Angeles General Hospital is noteworthy in this respect. Having switched to paper for serving food and drink to its 2,600 patients, it was able to release 75 kitchen helpers for war industry jobs.

Other factors influencing worker morale and health include the properly conceived physical examination. At Lockheed, where new employees are taken on at the rate of 2,000 a month, every applicant is given a comprehensive physical examination not for the purpose of excluding applicants from work but to fit each man to his job. This conception of the examination tallies with that recommended by the Committee on Healthful Working Conditions of the National Association of Manufacturers which advises, "Examinations should determine the individual's fitness for the job and permit placement of applicant or employee on work which he can perform without harm to himself or to his fellow employees."

GOOD SURROUNDINGS HELP MORALE

Decent surroundings are vitally important for morale as well as health. Studies show improper lighting and ventilation affect a man's ability to work. Authorities unanimously favor abolition of such potential disease carriers as common drinking glasses and advise that all drinking fountains should be equipped with dispensers of paper cups. Water splashing in a worker's face is not only aesthetically disagreeable, especially to women, but recent studies at the University of Pennsylvania have shown that splashing water may carry bacteria to fountain users. With a goose-neck attachment, and a dispenser of paper cups, a bubbler fountain may be easily converted to provide a sanitary drink.

Plant managers have found adequate washroom facilities, with plenty of hot water and shower rooms for men engaged in heavy work, are profitable. One manager whose plant offers such facilities observes significantly, "Few men feel grouchy after a good shower." Even music is a remedy. In one California plant where aircraft parts are manufactured, music is selected by employees. Promptly at 8 a.m. the music starts on an automatic phonograph and is distributed by amplifiers throughout the plant. It continues all day with exception of the lunch hour. Scientific investigations, which prove that men actually work in harmony with certain rhythms, support this plant's actions.

RECREATION FACILITIES IMPORTANT

Finally there is recreation. Aircraft plants, often situated on the outskirts of town, might follow the example of the American Rolling Mill Company at Middletown, Ohio, which, on adjacent property, developed athletic fields, a park, and a golf course. The desire for recreation, especially by the army of young night workers in aircraft plants, can hardly be minimized in view of the fact that these youngsters have, of their own volition, formed the Defense Workers' Recreation Club in southern California. Composed of 10,000 workers who toil from 4 p.m. to midnight, it holds "swing-shift jamborees" after midnight in the Glendale (California) Civic Auditorium. Fat pay envelopes have enticed them to take these jobs, though the hours kept deprive them of normal social activities. Provisions at or near plants for dancing, bowling, and motion pictures will make not only good but enthusiastic workers.

Both the Army and Navy have recognized the importance of morale in their industrial plants and have followed with action. The Navy gives 'E' awards to ordnance plants which produce on schedule and are otherwise considered to be doing "bang-up jobs." A ceremony, with plenty of gold braid present, marks the presentation of the award to a plant. The Army has appointed a special group to handle industrial morale work. Keynote of its policy is to make workers feel that victory for the United States depends on their doing their jobs well. (See From the Fight to the Factory, AVIATION, February, 1942.)

HEALTH PROGRAM NEEDED

Industrialists launched on all-out war programs are already puzzling over absenteeism records and exclaiming, "Something must be done." That "something" can be accomplished once it is realized that the proper functioning of manpower depends upon good health and morale. The steps by which absenteeism can be reduced then become apparent. The answer may be found in a general health program which provides workers with such comparatively simple assets as nutritious food, single service paper cups and containers to protect against infection, recreation, physical examinations, and health education. Such a program, designed to reduce illness, automatically removes factors contributing to faulty morale.

America At War

(*Continued from page 53*)

predict that there'll be a hot time over many of those towns this spring.

The British turned in a grim sample of what can be done, at Billancourt near Paris, laying waste the great Renault motor and plane works, and killing an enormous number of persons. You may wonder why, if it's so easy to destroy factories, there are still any in Europe. The answer, reading from this distance, seems to be a surprise. The Germans just didn't expect it, because the Allies have tried so long to keep from offending France. Since Europe has so many important cities to defend, against Britain's few, air surprise may work against the Nazis again and again. Superiority in the air, by either side, would accomplish the same devastating result as that at Billancourt.

HEAVY AIR ATTACKS TO COME

It still seems unlikely, with the Russians getting closer and in better bombing range of Germany, that the Germans will ever again muster enough air power to rip England apart as they did before. Chances are that Germany will be heavily attacked by air from both fronts this summer, and she will have to split her air forces accordingly.

Incidentally, the raid on Billancourt was a hedgehopping job. The planes went down and laid their eggs right on the spot. This apparently was true also of MacArthur's little but destructive attack on Jap shipping, with small bombs lugged in P-40's.

FINAL WORD ON KELLY

The sinking of a Jap battleship by Colin Kelly's air crew is old now, but it's not too late to clear up a popular misunderstanding of it. Most people thought Kelly flew a torpedo plane, against the ship's fire. He didn't. A member of the crew has been permitted to tell the story. The crew of eight or ten, in a four-engined bomber, spotted the ship, a short flight off Luzon, and, after looking things over, decided to let go on her. They made a run from a low altitude, seemingly about 10,000 feet, and dropped all three of their big bombs at once. One of them hit the deck, and the other two straddled the ship. It was a bombardier's dream. Then some Jap pursuits shot the bomber up. It went into a scud of cloud, disintegrating. Kelly ordered his men out, staying with his ship to the last. Apparently he was unable to get clear due to the violent movement of the crippled plane.

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Each hour of production hastens the day when America's fighting planes, superior in numbers on every front, will strike like bolts from the blue.
One of the many factors which give American planes an "edge" in altitude, maneuverability and reliability is the dependable performance of Delco explosion-resistant fuel pump motors. Conforming to latest military requirements, these lightweight motors safeguard the flow of fuel in starting, transfer and booster duty.
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Struts for P-38

(Continued from page 77)

vide the proper work angle to secure the best flow of the welding material.

FOURTEEN OPERATIONS IN A SINGLE SETTING

The interior diameters are bored on a special W. F. & John Barnes Co. machine, in which the work is held stationary and the tool head is moved hydraulically to feed the boring bar through the work. Four different diameters are bored including the air chamber, oil chamber, piston bore and lower packing gland recess which is later threaded. The cylinder is clamped in three places for maximum rigidity, and the boring bar is piloted through the work by a tail-stock bushing, the bar first being passed completely through the work before any cutting starts. A roughing cut of about $\frac{1}{4}$ in. is first taken and a finishing cut of about $\frac{1}{16}$ in. follows. Cutting oil is fed to the tool through the boring bar at the rate of about 40 gpm. A total of 14 operations is performed while the work is held in this set-up. Following the boring three sets of internal threads are tapped for upper and center plug and lower cylinder sleeve.

HEAT TREATMENT AND ASSEMBLY

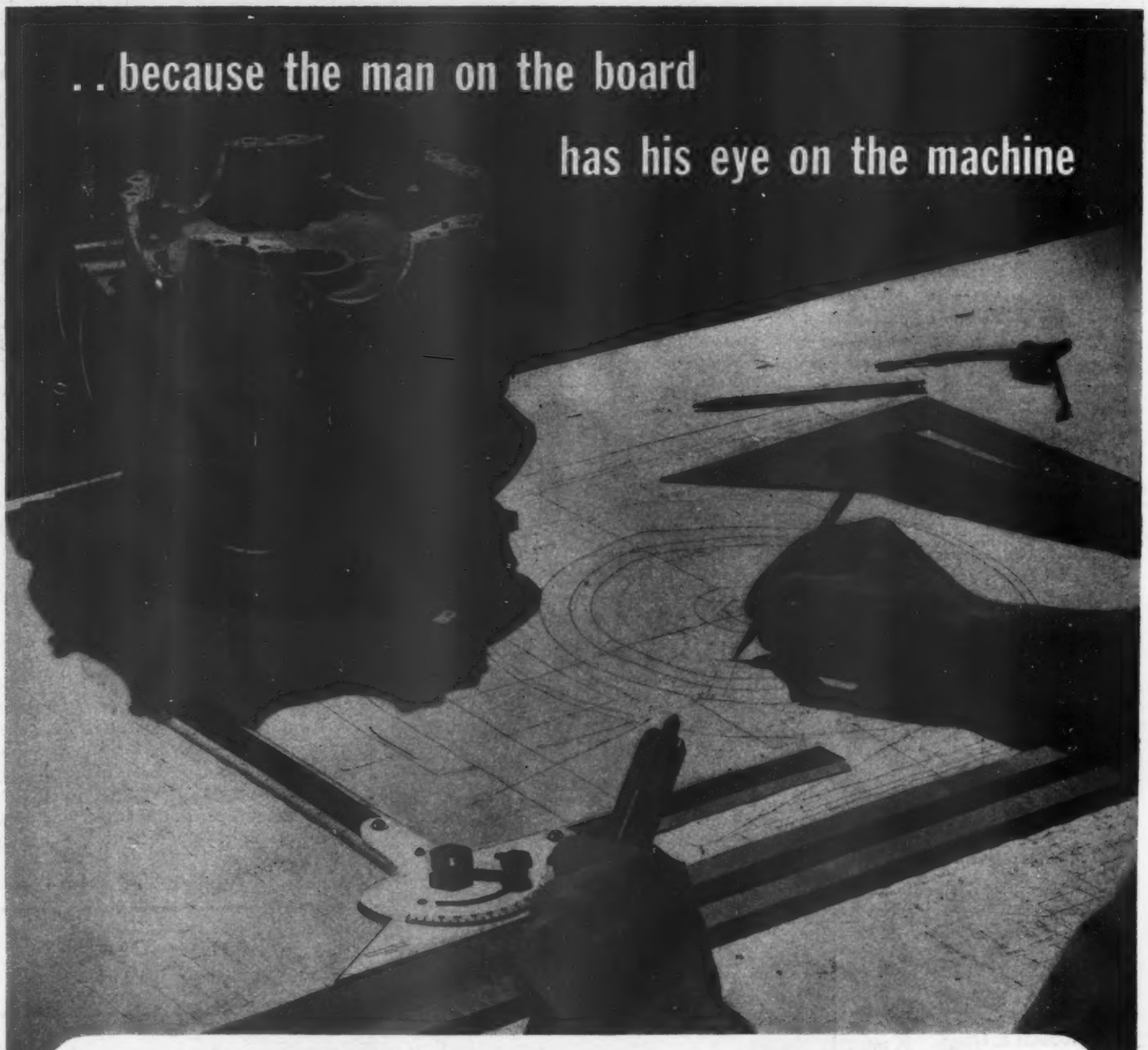
The cylinder is now ready for heat treatment. This treatment, as with other operations, is controlled with great care and precision in order to secure a uniform strength in all cylinders of 180,000 psi. Two groups of electric furnaces are used, one for hardening, the other for drying. Both are maintained at the correct temperature through use of Leeds & Northrup Micromax recording controllers. Natural gas is used to provide the controlled atmosphere and a large hood is used while transferring the parts from the furnace to the quenching tank, to reduce scaling effect. During tempering the cylinder material is brought to a hardness of 39 to 42 Rockwell C., and all machining, except rough turning and boring and internal threading is done at that hardness.

The surfaces of the cylinder are then cleaned by sandblasting following which the assembly is Magnaflux inspected.

There follows a lathe operation to finish the tube facing for length and to turn a portion of the cylinder for steady rests for grinding and honing. The piston recess and packing gland recess are then honed following which all threads are capped to clean.

Two plugs are threaded and sweat

. . because the man on the board has his eye on the machine



HECKER tool engineers think in terms of the man on the machine. They can do this because many of the tools, jigs and fixtures they design go to work right here in the **HECKER** plant. We're fabricators of airplane parts, as well as tool designers and builders.

This makes the **HECKER**-designed tool, jig or fixture a better producer, wherever it goes to work. The bugs are taken out while the job is still on paper. That's also why some of the country's biggest aircraft and war-production plants are using **HECKER** tooling service for faster results from their machines.

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soldered into the main cylinders. The upper plug seals the air chamber, while the lower serves as an orifice plate. Both are first tinned then screwed into place, after which the cylinder adjacent to the plug is heated from the outside to a temperature sufficient to melt the solder and then is allowed to cool.

The packing gland chamber is then ground followed by the grinding of three external surfaces to produce specified wall thicknesses. After straddle milling the three sets of lugs previously welded in position in semi-finished condition, the lug holes and the upper fulcrum hole in the cylinder are drilled. The radius is then milled on the torque link lug and the external thread on the lower end of the tube is ground. The principal machining operations are completed by finish boring the upper cylinder end for the Welch plug. After burring and stamping the serial number, the assembly is ready for final inspection.

INSPECTION ROUTINE

Frequent inspections are made throughout the manufacturing process. The inspection has been put on a production basis without sacrificing the necessary precision. For all dimensional checks this is accomplished through the help of special gages and fixtures which eliminate hand set-ups and make the operation semi-automatic.

Magnaflux equipment of the most modern type permits rapid examination of the materials themselves to reveal cracks and flaws. All welds are subject to magnafluxing. A total of eight different magnafluxing examinations are made on the cylinder alone in the course of its manufacture. All batches of steel are submitted to exhaustive metallurgical analysis. Each set of parts that is heat treated carries a test specimen which is then checked for strength and hardness as a guarantee that the heat treatment is to specification.

After the final inspection, the outside diameter of the cylinder is cadmium plated except the upper end, which fits into the fulcrum recess. The interior chambers are cleaned and boxed and the nameplates sweated on and the unit finally assembled for painting and shipping. Before painting, however, the assembly is filled and tested for leaks and run in on hydraulic presses.

As indicated before, these shock struts are of conventional design and of simplified type. We believe, however, that much of the credit for the unfailing performance and reliability in service must go to the limitless care with which they are manufactured.

Propeller Design

(Continued from page 73)

under ground and climb conditions. The advisability of using cuffs is usually determined on trial flights of the initial installation.

FUNCTIONAL TEST FLIGHTS

On most installations it is desirable to conduct functional test flights to check general operation, high pitch settings, feather angles, etc. After such tests have been made and the requirements for acceptance have been met, it can then be said the propeller design has been completed.

The foregoing is a general discussion meant to outline the high points in coordinating propeller design and installation with airplane design. There are many additional details, more or less minor, which necessarily have been omitted, but it is hoped that the importance of considering the modern propeller in the early stages, and throughout the airplane design, has clearly been defined.

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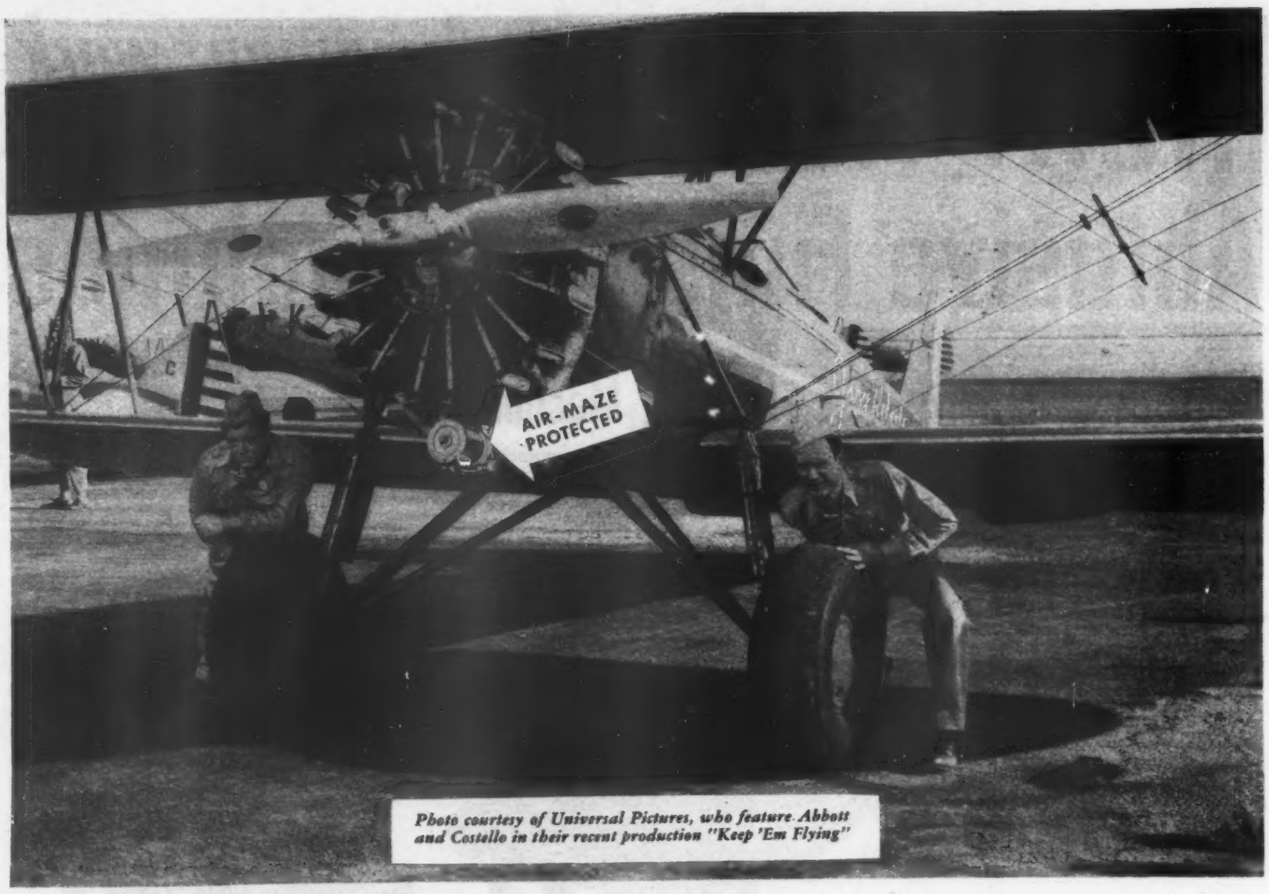

Photo courtesy of Universal Pictures, who feature Abbott and Costello in their recent production "Keep 'Em Flying"

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Designed to meet every requirement for accurate finishing, this Delta Abrasive Disk Finishing Machine is a high-grade tool for high grade work. From its completely machined, true-running 12" disk to its large surface table and the husky spindle of the belt-drive machine, carried on self-sealed ball bearings, it is designed for long life, low power consumption and accurate, dependable results.

Made on two models; one a direct-drive unit employing either a ½ H.P. or a ¾ H.P. ball-bearing motor. The disk in this unit fits directly onto the end of the motor shaft, making the machine completely self-contained. The other model is a belt-drive unit, which makes it possible to use any motor available, to use motors built for odd frequencies or voltages and to vary the speed to suit individual operations.

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Design Charts

(*Continued from page 82*)

If a wall thickness other than 0.103 in. is used, the margin of safety or the stress ratio may be obtained in the same manner as was done above in the case when Fig. 3 was used.

It will be noted that at the bottom of Figs. 3 and 4 there is an additional family of three curves for aluminum alloy tubes. The upper curve is for 24ST either stretched or unstretched. The intermediate curve is for stretched 17ST, and the lower curve is for unstretched 17ST. Suitable curves could be similarly drawn up for other materials if modulus of rupture curves were available.

In the preparation of these curves, Fig. 1 was enlarged several times and the values carefully measured. All of the computations were carried out on a calculating machine and a large number of points were calculated for each curve. Raymond L. Quigley, an engineering student at Curtiss-Wright Technical Institute carried out most of the calculations and plotting of the curves for Figs. 2, 3, and 4. These were plotted on charts 14x22 in. then reduced. The accuracy of the results obtained is comparable to that of the customary procedure. A higher degree of accuracy may be achieved over the customary procedure when slide rule is used, because of the fact that fewer operations are involved and these do not include a relatively small difference between two numbers, such as is obtained in computing the section modulus of thin walled tubes.

There has been a growing trend away from the use of fractional parts of an inch in the aircraft industry. With all of our computations done in decimals, and with all accurate measurements in the shop similarly made in decimals, the fraction has little to recommend it. The curves of Figs. 3 and 4 are based on ratios instead of on standard sizes. They hold equally well for a tube the size of a hypodermic needle or one the size of a smoke stack. The writer hopes that they will aid in discouraging the needless use of fractional dimensions which are frequently used just because certain tables of sectional properties are available. When tubular parts are machined inside and out and when weight saving is of paramount importance as it is in aircraft work, the logical thing is to make tubular members the size necessary to meet the stress requirements. Whether or not this size is listed in a handbook is of small importance.

The fact that these charts obviate the necessity of computing the section modulus and fiber stress should not concern us. These are of little interest except as a means to an end. Good precedent has been established for this procedure in the common use of column charts. We are essentially interested in finding, accurately and promptly, the minimum size of members necessary to meet the structural requirements. This can be accomplished by means of Figs. 3 and 4.

Cleaning Alclad

(*Continued from page 85*)

welds, others required that the pieces be welded within a few minutes or few hours of the cleaning process. In mass production such critical methods are unsatisfactory because some production parts require 4 to 12 hours to assembly after cleaning for spotwelding.

CONSISTENT RESULTS ASSURED

The method of cleaning finally adopted permits the parts to be welded at anytime within three days after the cleaning operation, and also gives consistent results as far as weld strengths are concerned. The details of operation are as follows:

(a) Oil, identification marks, and other foreign substances are removed by immersing the parts in an aluminum cleaner, such as Navy Spec. C-67B, at 190 deg. F. or higher for approximately five minutes. In case the parts are heavily coated with oil or grease, such as used in punch press operations, a trichlorethylene degreaser is used.

(b) If aluminum cleaner is used, parts are thoroughly rinsed in cold running water.

(c) Parts are dipped for about one minute in a 20 percent by volume nitric acid solution.

(d) Parts are thoroughly rinsed in cold running water.

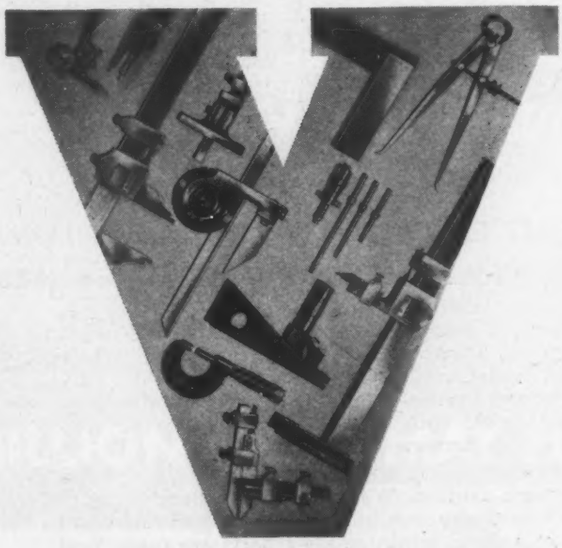
(e) Parts are dipped for 45 sec. in a 6 oz. per gal solution of Oakite No. 30 at 200 deg. F.

(f) Parts are thoroughly rinsed in cold running water.

(g) Parts are dipped for about one minute in nitric acid as in (c).

(h) Parts are thoroughly rinsed in cold running water.

(i) Excess water is removed from parts by blowing with clean compressed



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air and where necessary are wiped with a chamois.

(j) After drying, parts are assembled for spotwelding which may be done anytime within three days with assurance of consistent welds.

Present production capacity is expected to be tripled or quadrupled with the installation of new stainless steel tanks of large capacity. Overhead hoists for handling the parts will be equipped with automatic timing devices to insure accurate control of the process.

Even though this new method for cleaning Alclad has been an important factor in Fleetwings' fabrication progress, constant research continues underway to assure additional improvements.

Strength Analysis

(*Continued from page 99*)

$2 \times 7371 = 14742$ lb. Since this load is greater than the load which can be applied to the joint without exceeding the allowable load on both sections A-A and B-B, it can be seen that section C-C is the least stressed of the three sections.

An inspection of all of the results obtained in the preceding computations indicates that the total shearing strength of the rivets is less than total bearing strength and also less than the total tensile strength of the .081 plates. The tensile strength of the splice plates can be determined in a manner similar to that used in the analysis of the abutting plates. However, it is assumed for this joint, that the strength of the two .040 plates at all sections is satisfactory. The only remaining factor to be considered is the tear-out strength of the various plates making up the joint. If an edge distance of two diameters is maintained on all rivets in the driving process, it can safely be assumed that the joint will not fail in this manner. Consequently, it can be concluded that in this particular example the strength of the joint is determined by the total shear strength of the rivets, that is, shearing of the rivets is the critical condition.

TOUGHENING "CYCLONES"

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MANUFACTURERS OF INDUSTRIAL FURNACES · JANITROL GAS FIRED SPACE HEATING EQUIPMENT · AND NATIONAL AIR CONDITIONING SYSTEMS

Side Slips

(*Continued from page 147*)

the student, in the rear seat, generally survived. To this unique characteristic we can credit the continuing existence of many of our most prominent executives and pilots.

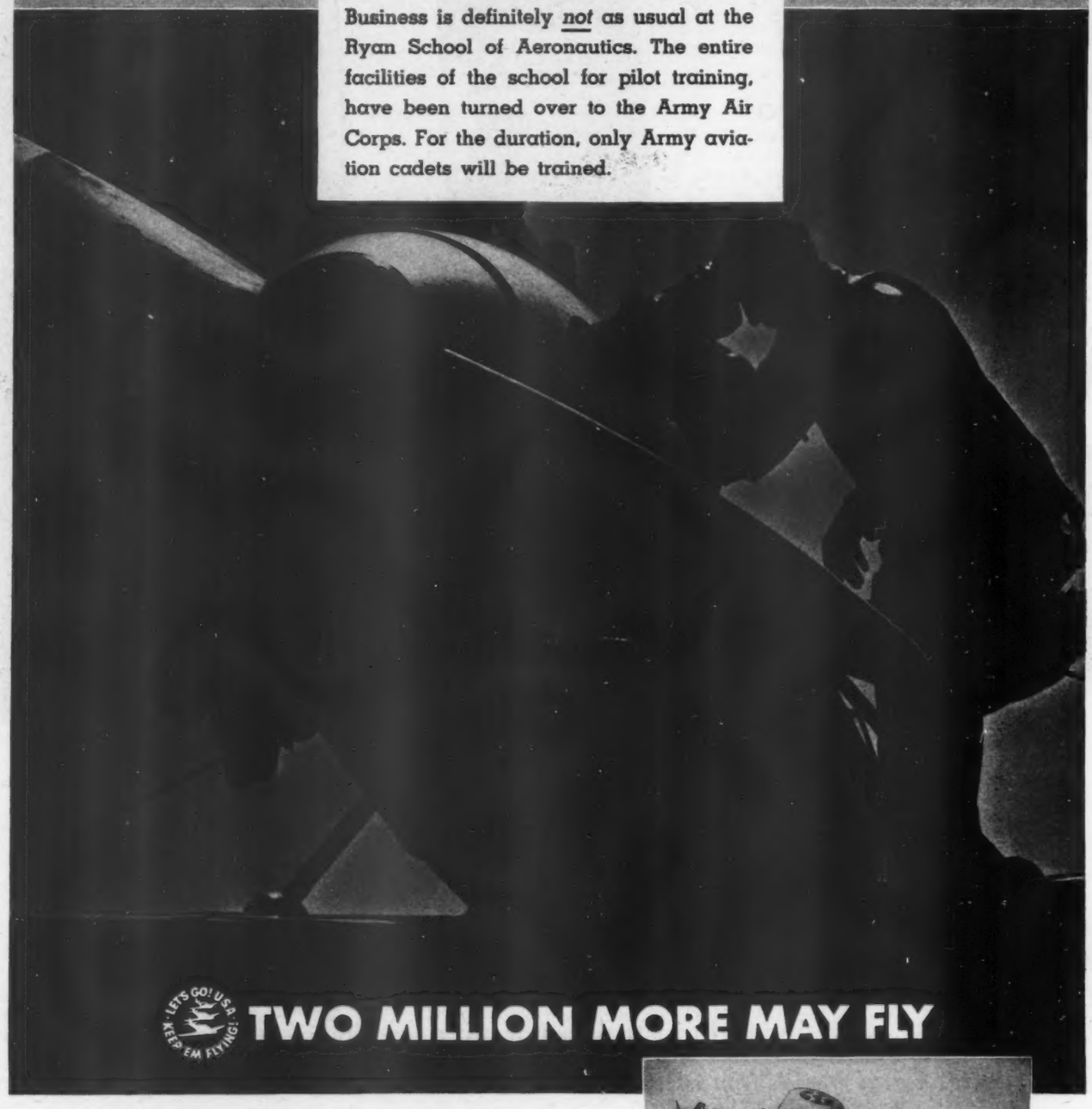
It was hard to see through the yellowed and cracked windshield; the cloth cover of wings and fuselage was oil soaked; half of the spokes were out of the wheels; the wings were a forest of struts, wires and skids; the cowling had more patches than original metal; moss grew on the tail surfaces.

Ah, gentlemen, they *were* fearfully and wonderfully made, and they flew until rust, and termites, and corrosion, and the elements had grounded them once and for all. We fear their day is done, and so we say hail and farewell, Jenny,—you were a good grandmother of the amazing aviation of today.

» ACCORDING TO THE "DEFENSE HIGHWAY ACT", passed by Congress, flight strips for aircraft from 300 to 800 feet wide and 800 to 8000 feet long are expected to be built alongside of selected junctions of highways. As the Act refers to them as "flight strips" we're wondering if it was sponsored by Gypsy Rose Lee or any of the other burlesque queens. Or—possibly the sponsor was the young lady in California who recently achieved some publicity from her habit of sun bathing while soloing her plane.

Business not as usual

Business is definitely *not* as usual at the Ryan School of Aeronautics. The entire facilities of the school for pilot training, have been turned over to the Army Air Corps. For the duration, only Army aviation cadets will be trained.



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Escher Wyss Propeller

(*Continued from page 101*)

of high centrifugal forces, for the controllable mechanism and the governor apparatus of the new Escher Wyss variable-pitch propeller.

DESCRIPTION OF THE PROPELLER

The Escher Wyss variable-pitch propeller[3] is operated purely hydraulically and permits, in principle, the execution of the maneuvers mentioned above and this with a small number of simple and sturdy parts. The entire mechanism consists of the actual control hub, the engine-driven governor and oil pressure generating unit, the latter two combined in a single casing, as well as the conduits leading from the governor to the propeller shaft.

In its design the pitch-control mechanism strongly resembles our thoroughly proven Kaplan turbines and screw pumps as well as our variable-pitch ship propeller types. As in their case, the pitch-changing forces in both directions, i.e. for high or low pitch setting, are generated by positive oil pressure. The only source of pressure oil supply is the engine oil. The utilization of mass centrifugal forces for turning the blades has deliberately been refrained from. For propellers with a wide range of pitch adjustment and the speed and reliability they require in the blade angle change, only such adjustment methods are admittedly eligible as can be controlled from the exterior in every case, since blade positions must be passed through in which the forces tending to cause the blades to go into low pitch are very small or eliminated altogether due to the centrifugal forces.

An important new element in the control hub is the ingenious automatic locking device for all blades which is built into the control cylinder. Should the oil pressure fall below a determined value owing to damage to the oil supply system or also to deliberate release by the pilot, the locking apparatus instantaneously and in any position prevents any further axial motion of the control cylinder built into the hub and, thus, of the propeller blades.

The propeller is then ready to operate in the manner of fixed-pitch types. This provides the desired freedom from blade hunting around the longitudinal blade axis and makes possible in the case of even loads, e.g. under cruising conditions, an automatic relief of the oil and servo-motor systems and a corresponding economy in energy. The locking device operates so accurately and instantaneously that it responds also to the slightest load variations. When the propeller is employed as a brake producing negative thrust, such a safety device, which simultaneously prevents the blades from inadvertently returning to negative pitch settings, is highly important.

In a certain normal pitch range, which can be adjusted to take care of individual requirements, the Escher Wyss propeller operates as a constant-speed propeller. The pitch limit of this range which is automatically controlled by the governor can be passed only by deliberate action on the part of the pilot. As a result, the blades are set at the brake or feathering positions only when they are fully under control of the pilot. If not required, the extreme positions of the present type can be eliminated altogether by suitable adjustments to the control cylinder, whereupon the propeller operates as a normal, modern constant-speed unit.

The one-piece hub casing (see AVIATION Sketchbook, p. 115) forms the blade-mounting structure and encloses and protects all the remaining moving parts. On a central, hollow guide tube which offers the possibility of firing through the hub—a fixed piston is mounted. Above the piston and guide tube is attached the actual control cylinder. This cylinder is displaced along the guide tube by the boosted oil supplied and automatically controlled by the constant-speed governor pump; it reaches either face of the piston through corresponding bores in the central guide tube. At its forward end the control cylinder carries a ring with articulated connecting rods which transmit the pitch-adjusting forces to the blade sockets and thus cause the axial rotation of the blades. The simple construction employing connecting rods for the transmission of the forces gives a connection which operates without play for practically unlimited periods. The connecting rod principle has always been found to be a safe, simple and easy solution of the problem also in the other machines produced by Escher Wyss (turbines, pumps and blowers).

The entire locking mechanism is attached to the fixed piston in the interior of the hub and completely submerged in oil. Before the pressure oil reaches one or the other face of the piston it operates small spring-loaded auxiliary pistons whose motion actuates locking parts which can mesh with corresponding parts in the interior of the control cylinder. When the pressure oil arrives it first releases the spring loaded locking devices between piston and cylinder; only then can it flow into the lines leading to the forward or the rear chamber of the control cylinder and axially displace the cylinder. The entire apparatus is automatically operated by the governor oil but can be switched over to manual operation by the pilot at any time.

Although the Escher Wyss hub contains this additional apparatus which is not featured in current types of propeller, its exterior shape is not clumsy or bulky. Special care has been taken to provide facilities for the easy assembly and removal of the individual parts. The blades are readily screwed in or out from the outside without necessitating the dismantling of the controllable mechanism located in the center. On the other hand, the pitch-adjustment and locking apparatus may be taken out of the hub and replaced after the removal of the hub front inspection plate. This special feature of the Escher Wyss variable-pitch propeller offers considerable advantages in practical operation.

The propeller is basically designed for fitting on flanged or grooved shafts. In both cases the main components are identical. As a result of the methodical development and in spite of the wide pitch angle range the weight of the propeller is remarkably low. (The complete three-blade propeller for 1,000 to 1,200 hp. weighs about 270 lb.; the complete auxiliary unit about 9.5 lb.) In the event of engine failure, or on the ground, the pitch angle can be adjusted by means of a small hand pump or by compressed air.

A special testing plant has been developed to permit of the stresses, which occur during flying under the most widely differing conditions, being exactly studied and measured and their influence on the various parts determined. The accompanying illustrations Figs. 5-9 give an idea of some of the preliminary development work.

For load tests on the hub, a measuring frame is used. At the three corners of the sturdy frame, freely movable hydraulic cylinders are supported, the piston rods of which are screwed into the hub under test in exactly the same manner as the blades of the propeller. By pumping oil under pressure into the hydraulic cylinders arranged in the corners of this frame, stresses corresponding to the centrifugal forces are exerted on the blades. For test purposes same can be increased manifold. The hydraulic loading cylinder and the rods are designed in such a manner that the adjusting mechanism in the hub also can be operated and tested under load. This check of the hub body primarily relates to measurements of the stresses occurring in the various parts of the casing. Figures 8 and 9 show calculation results and stress measurements carried out by means of tensometers on a test hub. The stresses on the hub casing are as uniform as possible, being ascertained with the aid of a soap-skin model (Fig. 5). The supporting sur-

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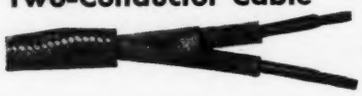

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faces of the blade thrust bearings are represented by wire rings between which the soap-skin hangs.

Apart from such static testing methods, overspeed tests can also be carried out in a special pit. With the aid of a small steam turbine, the hub can be rotated at high speed. In place of blades, steel stumps are screwed into the blade holders, the centrifugal force of which corresponds to that of the relative propeller blades. In this manner, the power required for such overspeed tests can be considerably reduced. For normal shop tests special test beds have been installed on which the propeller can be operated together with motor drive and governor under conditions approximating service operation.

Following the completion of this exhaustive test program, the Escher Wyss propeller has been adopted by the Swiss Air Force and is now produced in series for installation on fighter planes.

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(1) Attention has been drawn to the great importance of all these possibilities, of which hardly any are yet exploited in practice, by:

ACKERT: "Probleme des Flugzeugantriebes in Gegenwart und Zukunft." (Present and future problems of airplane propulsion), Schweiz. Bauzeitung, Vol. 112, No. 1 1938, Page 1 and "Verstellpropeller," Special number published on the occasion of the Centenary of the S.I.A., Swiss Federal School of Technology 1937, Page 161, further "Constant speed-Luftschrauben", Flug-Wehr und -Technik No. 1 and 2, 1939.

(2) C. KELLER:—"The Escher Wyss Variable-pitch Airscrew" Escher Wyss News No. 4/1938, Page 75, or in Flug-Wehr und -Technik, Volume 1 No. 2, February 1939. "The Escher Wyss wide-range C. P. Airscrew" "INTERAVIA" Supplement to No. 717-718 dated 15. 7.40.

Synthetic Resins

(Continued from page 105)

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majority of failures were observed not in the wood itself, but in the joints.

Exposure tests conducted by Brouse, at the Forest Products Laboratories, have demonstrated that joint failures with animal, vegetable and casein glues could be attributed primarily to a chemical hydrolysis of the glue, a decomposition of parasitic micro-organisms, or a mechanical failure due to stresses developed in the wood, the latter being particularly serious if the glue is in a softened condition.

It had already been demonstrated that certain resin adhesives could resist water at elevated temperatures indefinitely, and were completely immune to the destructive micro-organisms. At the same time, they resisted chemical hydrolysis, and were much stronger than the common glues.

However, these resin adhesives were used in hot presses at temperatures between about 250 deg. and 325 deg. F. and it was clearly impractical to hot-press as assembled wing panel. The

Ameripol compound bent 180° around a ¾" bar while at −50° F. No cracking or checking.

Right from the ice-box come the cold facts about AMERIPOL*

A big producer of aircraft accessories found that the V-packings being used developed leaks because of cracking and checking in the sub-zero temperatures of high altitudes. Hearing of this difficulty, Miller submitted samples of Ameripol oil packings and oil seals for hydraulic systems and had them put to the test in that company's own laboratory.

This was the test: Cycling the packings under operating conditions at room temperature, at −50° F., at 158° F. At the end of each cycling, static tests were performed at pressures from zero to 2500 lbs. per square inch.

This was the result: At no time was there a trace of leakage. Ameripol got the job.

If you need a material that not only retains its flexibility at −50° F., but also offers low oil absorption, extreme resistance to abrasion and heat, is non-corrosive to metals, and gives long service life, then Ameripol's your answer. Miller's technical staff and facilities are at your service.

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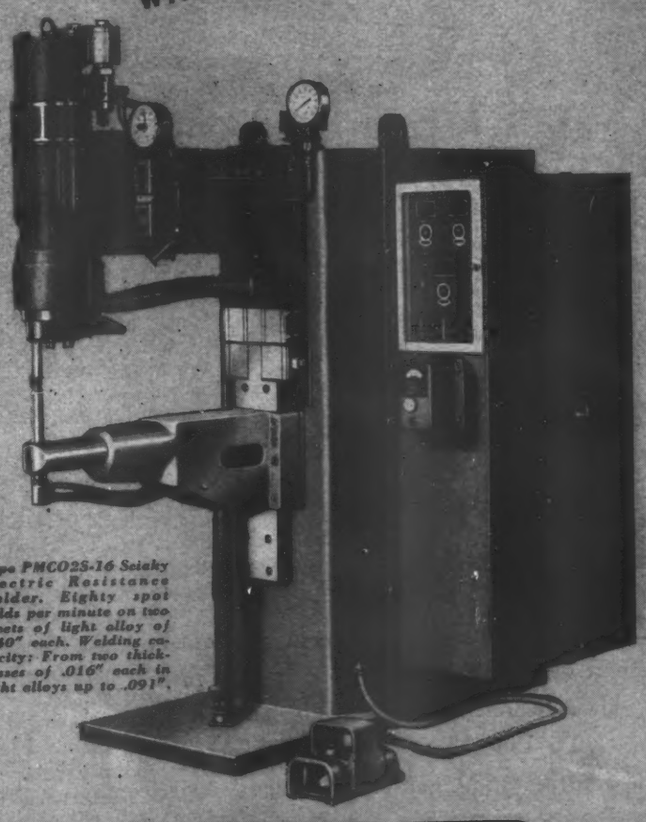
A NAME NEW TO AMERICAN INDUSTRY PROUDLY TAKES ITS PLACE WITH THE LEADERS IN THE BATTLE OF PRODUCTION FOR VICTORY



Type PMCO2S-16 Sciaky Electric Resistance Welder. Eighty spot welds per minute on two sheets of light alloy of .040" each. Welding capacity: From two thicknesses of .016" each in light alloys up to .091".

YESTERDAY...

Just two short years ago, after 16 years of development work, Sciaky introduced to America the Stored Energy Principle and Variable Pressure Cycle for spot welding of aluminum alloys. These two innovations have contributed more to the advancement of large scale production of spot welding in the aircraft industry than any other factors.

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After brief but convincing demonstration proving its many advantages, and fully satisfying army and navy authorities, the Sciaky resistance welding process is enthusiastically accepted by leading aircraft manufacturers. More Sciaky machines are now used for spot welding aluminum alloys than all other makes combined.

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Re-designing of products to take full advantage of the extraordinary economies and efficiency of the Sciaky resistance welding process will result in cheaper, lighter and better airplanes, automobiles, railway cars, household utilities, and scores of other products.

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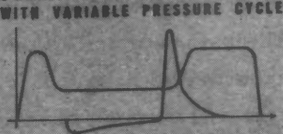

The combination of the Sciaky Stored Energy Principle and the Variable Pressure Cycle produces sound, uniform welds in aluminum and other alloys at high speed with low current consumption.

This announcement is not to be construed as a solicitation for inquiries by manufacturers of civilian products. Our entire capacity production is booked for many months in advance to supply manufacturers of military aircraft and other war material producers.

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need for a cold setting resin adhesive became apparent.

COLD SETTING ADHESIVE DEVELOPMENTS

After some three years of intensive work through the vinyl and butecite resins in the thermoplastic class and the urea and phenol formaldehyde resins in the thermosetting class, two formulations based on a phenolic resin of high molecular ratio were evolved at the Bellanca Aircraft Corporation.

The trail of research led back to the elementary mechanics of gluing, and to the study of the microstructure of wood. The problems of non-uniform absorption and joint starvation were eventually overcome and a satisfactory control was established over a delicate chemical reaction, with the invaluable help of the Catalin Corporation.

The ideal of the strictly cold-setting resin has not yet been achieved. The author has tested any number of cold-setting preparations, and it may be taken as axiomatic that the uniformity of the synthetic resin bond is only as good as the uniformity of temperature, and the dependability of the bond decreases as the temperature is reduced.

The formulations were therefore developed to effect a cure of the resin at 140 deg. for a length of time compatible with production requirements.

The problem of maintaining a large insulated room at a temperature of 140 deg. involved no special difficulties and the humidity was readily controlled to maintain stability in the wood at that temperature.

The formulations mentioned have been extensively tested and evidence has been presented to show that they will produce uniform dependable joints of typical phenolic resin performance, on any of the species of wood commonly used in aircraft manufacture, while the mixing, handling, spreading and clamping properties are almost identical with those of casein glue.

Its use in production has been approved by the Civil Aeronautics Authority and the partially completed wing shown in the photograph has been taken from the production jigs to illustrate the principles described. In addition, military airplanes incorporating these principles are being constructed for the U. S. Air Corps in connection with National Defense, but a description of them is not permitted at this time.

TEST RESULTS

A long series of comparative tests have definitely shown the superiority of the low temperature phenolic resin over the bonding mediums commonly used in airplane assemblies.

Shearing tests (see Fig. 1) of dry

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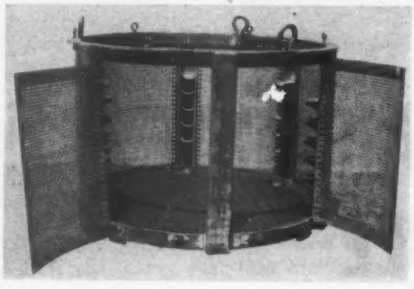
A group of Pickling, Dipping and Annealing Baskets. These baskets have a wide acceptance because of their high quality and carefully supervised manufacture. Furnished in any size, with perforations to suit your requirements.



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Every step in the manufacture of Packard aircraft cable is carefully controlled, to maintain absolute uniformity. Packard cable is always dependable.

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joints in the soft woods, such as spruce and bass, gave no particular advantage to the resin, since the casein joints gave just as high percentage of wood failure with comparable shear strengths. (See Figs. 2 and 3.) The superior mechanical strength of the resin was shown in the shear tests of the hardwoods, typified by birch and maple, where the average shear value was 2,778 lb. per sq. in. for the resin as compared to 1,732 lb. per sq. in. for casein glue. The specimens were of birch and the lowest percentage of wood failure was 80 for the resin as compared to five for casein.

In addition to cold water immersion, a boiling test was arranged consisting of a cycle of eight hours in boiling water, eight hours in cold water and eight hours drying. The cycle was continued for 200 hours, after which the specimens were manually destroyed. No evidence of joint failure could be found.

Another four foot panel of typical wing construction was immersed in a tank of boiling water for a day after which it was oven baked to develop violent shrinkage stresses. Subsequent examination showed that the resin bond successfully resisted the stresses, while similar panels with other adhesives completely disintegrated in the boiling water after only a few hours' immersion.

The test panel shown in the photograph has been cut loose from its moorings on the roof after over a year of exposure, while duplicate panels with other adhesives have long since collapsed.

With the rapid growth of both the plastics and the airplane industries, it is difficult to foretell their exact future relationships, but we may safely predict that the synthetic resins will increasingly continue to infiltrate the airplane structures and that their use will be associated with wood as a reinforcement and bonding agent in the new prefabricated structural materials, and as a reinforcement, binder and surfacer in the molded units.

References

6 V. E. Clark. Low Density Structural Materials, *Aero Digest*, July, 1939.
7. Don. Brouse. Exposure tests on Plywood, Forest Products Lab., Madison, Wisconsin.

Barrage Balloons

(*Continued from page 157*)

last year, the number of balloon barrage defences has grown to colossal proportions and few important areas are now left without balloons. The density of spacing has also been increased almost to the optimum.

The purpose of the barrage is not

Left, Hycar; right, rubber

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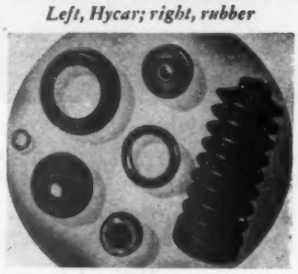
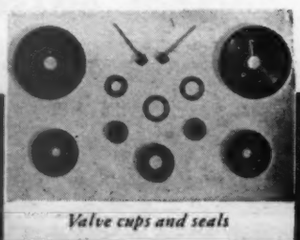


Typical precision-molded parts

Refueling hose



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essentially to bring enemy aircraft down, but rather to force them to fly above 5,000 ft. where anti-aircraft or fighter defences can deal with them. In particular, the deadly dive-bombing of local objectives is rendered impossible, and only the relatively inaccurate high-altitude bombing can be used.

Fear of flying into cables has also caused the enemy to take drastic precautions with its aircraft, which are sometimes fitted with devices such as the fender form, designed to protect them, but which add weight and decrease bomb load and speed.

CONVOY BALLOON BARRAGES

The most recent application of balloon defence has been in the installation of this apparatus on merchant ships in convoy, and it has been most beneficial in reducing the number and efficiency of dive-bombing attacks on ships.

Skippers now have so much confidence in the protection thus afforded them, that they are reluctant to sail without their "sausage," and many cases have been recorded where Stukas have approached a convoy for an attack, but have given it up as a bad job on seeing the balloons go up. Before these were used, large kites were tried, but these were proved inferior. The naval type balloon is much smaller than the land type, having capacity of only 2,300 cu. ft. and mounting, instead of the bulbous stabilizing fins which are usually seen, four thin "shark's fin" stabilizers stayed by bracing wires.

BALLOON LOSSES LIGHT

Neither with the naval nor land-based type of balloon is there much wastage by direct attack from enemy aircraft. It is far too risky for the pilots concerned. By attacking the ballooons they automatically give their altitude to the anti-aircraft batteries which are only too glad to get the opportunity of an accurately-ranged target. Moreover, as one balloon goes down, another immediately ascends in its place, and manufacture and production is so well in hand that it can easily keep pace with losses through all causes. Greatest losses are incurred by damage from shell fragments of our own gunfire and, of course, lightning sometimes ignites balloons. High winds occasionally tear them from their moorings and they then drift across country and sea, or end their journey on a mountain side.

However, from all causes balloon wastage is comparatively light. There is a complete turnover of new gas bags every few months. Continuous maintenance is, of course, carried out on the site, and the fabric is periodically examined for tears and leaks which affect buoyancy, and these are repaired.

The barrage personnel was originally

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★ Just as Wilco research produced Electrical Contacts and Thermostatic Bi-metals which were chosen on the basis of their matchless performance and absolute dependability for use in practically every peace-time industrial device—so now these highly developed materials are being used for war purposes.

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★ Wilco Thermometals (thermostatic bi-metals) are being used with equal success in various instruments for the Army and Navy.

★ Fast growing, too, are the uses for Wilco Powder Metal Contacts in higher frequency applications above 20 amps.

Take advantage of more than 27 years Wilco experience. Without obligation send us your problems for analysis or write for a copy of the Wilco Blue Book of Thermometals and Electrical Contacts.

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AIRFIELD
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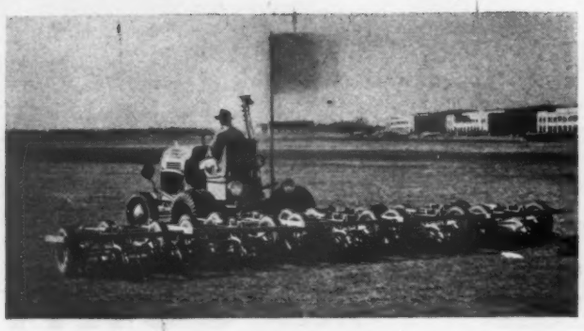
Solves your problem of developing and maintaining proper turf — faster, more efficiently



Frequent, regular cutting is necessary to develop thick, dense turf. Thick, dense turf accomplishes the following necessary objectives:

1. Keeps down dust which is a cause of too frequent motor tear-downs and parts replacements.
2. Helps eliminate hazards of loose stone, aggregate, gravel, etc., injuring propellers during motor rev-ups, take-offs and landings.
3. Absorbs rainfall, preventing muddy areas and the danger of serious skids.
4. Helps eliminate wheel marks which can be photographed from as high as 30,000 feet.

At 20 m.p.h. the Worthington Airfield "Grass Blitzer" cuts 46 acres per hour or 368 acres per 8-hour day — the largest capacity mowing machine ever developed. This high cutting speed enables the "Grass Blitzer" to keep out of the way of plane traffic. (A short-wave radio receiver is available to enable the field control officer to direct its movements and eliminate the danger of collision.)

Maintenance of Dispersion Fields is simplified by the "Grass Blitzer" Transport Trailer which enables the tractor element to haul the cutting units for immediate use when and where needed at highway speeds in excess of 30 m.p.h., eliminating the necessity of mowing equipment for each individual Airfield surrounding a Main Base.

Before purchasing old-style equipment it will pay you to investigate thoroughly the new Worthington Airfield "Grass Blitzer."

Tear out and mail this coupon, today, for handsome, illustrated catalog — "The Worthington Airfield 'Grass Blitzer' — A Study of Airfield Turf Area Grass Cutting and Maintenance Problems."

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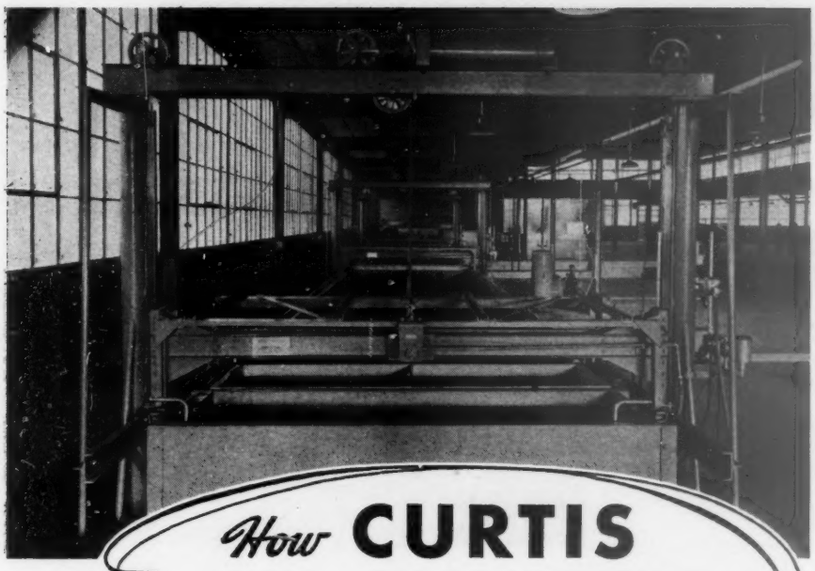

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Curtis Air Cylinders provide automatic transfer of work racks between the cleaning, plating, and rinsing units of the installation, which was installed by Crown Rheostat and Supply Company, Chicago. Each transfer unit is controlled by two Curtis Air Cylinders, one operating the lift mechanism vertically and the other operating the horizontal or transverse motion of the frame.

The installation eliminates lengthy drive shafts, affords any desired time cycle for the various steps in the transfer, and allows rearrangement of the entire sequence of operations at will. It greatly simplifies previous arrangements and has materially speeded up the production of finishing huge volumes of die castings.

Curtis Air Cylinders will perform almost any pushing, pulling, or lifting operation. They cannot be damaged by overloading and are immune from abuse. They provide exceptionally accurate control; easily operated by unskilled labor.

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entirely male, but recently women crews have been introduced and are proving more than capable of fulfilling the necessary duties. They undergo a course of training in the method of manufacture, maintenance and repair of the balloons, and in the operation of the winches, also the driving of the trucks. Some crews are now 100 percent W.A.A.F.—just another example of how women are being employed in ever greater numbers in Britain's war effort.

Patent Review

(*Continued from page 109*)

Airplane Wing. No. 2,275,038. John C. Whitesell, Norristown, Pa., et al., assignors to Edward G. Budd Manufacturing Company.—An airfoil made up of corrugated members of certain dimensions, with uniform pitch and amplitude, the members including a flange, the flanges lying in a plane, with corrugated hat-shaped intermediate section of differing pitch, the flanges of which are spotwelded to those of the first-named section.

Control Airfoil. No. 2,272,439. Paul E. Hovgard, Kenmore, N. Y., assignor to Curtiss-Wright Corporation.—A control airfoil assembly comprising a forward stabilizer terminating in a trailing edge having a material thickness, and a hinged control airfoil having an arcuate leading edge portion close to the stabilizer trailing edge surfaces. The arc of the leading edge extends outside of a continuation of the stabilizer trailing edge profile, whereby the forward portion of the control airfoil is thicker than the stabilizer trailing edge. The control airfoil has a straight surface profile tangent to the leading edge portion of its trailing edge.

Aircraft Sustaining Rotor Blade. Paul H. Standley, Huntingdon Valley, and Agnew E. Larsen, Jenkintown, Pa., assignors to Autogiro Company of America.—A blade for an aircraft sustaining rotor; its primary longitudinal structural element is a step-tapered elliptical spar with substantially uniformly tapered blade plan form throughout at least a major part of the blade length.

Helicopter Airship. No. 2,273,303. George R. Waldron, Tujunga, Calif.—Comprises a fuselage with a pair of rotating shafts extending upward, with adjustable pitch blades, the shafts being of differing lengths, through which power operates the blades.

Airplane. No. 2,272,522. Jacob Hojnowski, Nekoosa, Wis.— Features a retractable landing gear incorporating certain features so that the wings form a bracing element for the wheels in operating position.

Landing Gear. No. 2,272,699. John N. Gladden, Burbank, Calif.—Assignor to Bendix Aviation Corporation.

Aircraft Flight Control. No. 2,271,531. Edward E. Minor, Baltimore, Md., assignor to Glenn Martin Company.—A casing containing an electrolytic fluid, having first and second electrodes mounted in lower and upper portions respectively; a compass dial rotatively mounted and extending between these electrodes, the compass dial comprising lower and upper sheets of current conductive and insulating materials with a third electrode on this sheet of conductive material.

Duplex Aileron Control. No. 2,271,763. Harlan D. Fowler, San Diego, Calif.—An airfoil including a cambered wing of a main portion and a trailing portion with rearwardly extensible flap adapted to be faired under the trailing portion. The flap included a nose slat at its leading edge which can be operated to open and close a slot, and there is a mechanical means for controlling the nose slat when flap is either retracted, partially or fully extended.

TEN MILES FROM MIAMI IT'S 110° BELOW

YES, 10 miles above Miami, and we mean straight up, it's colder than at the same altitude over the North Pole. It may be 50 degrees colder, and that's no military secret.

This condition and similar ones impose problems on our military aircraft and personnel—and their solution is the immediate concern of AiResearch.

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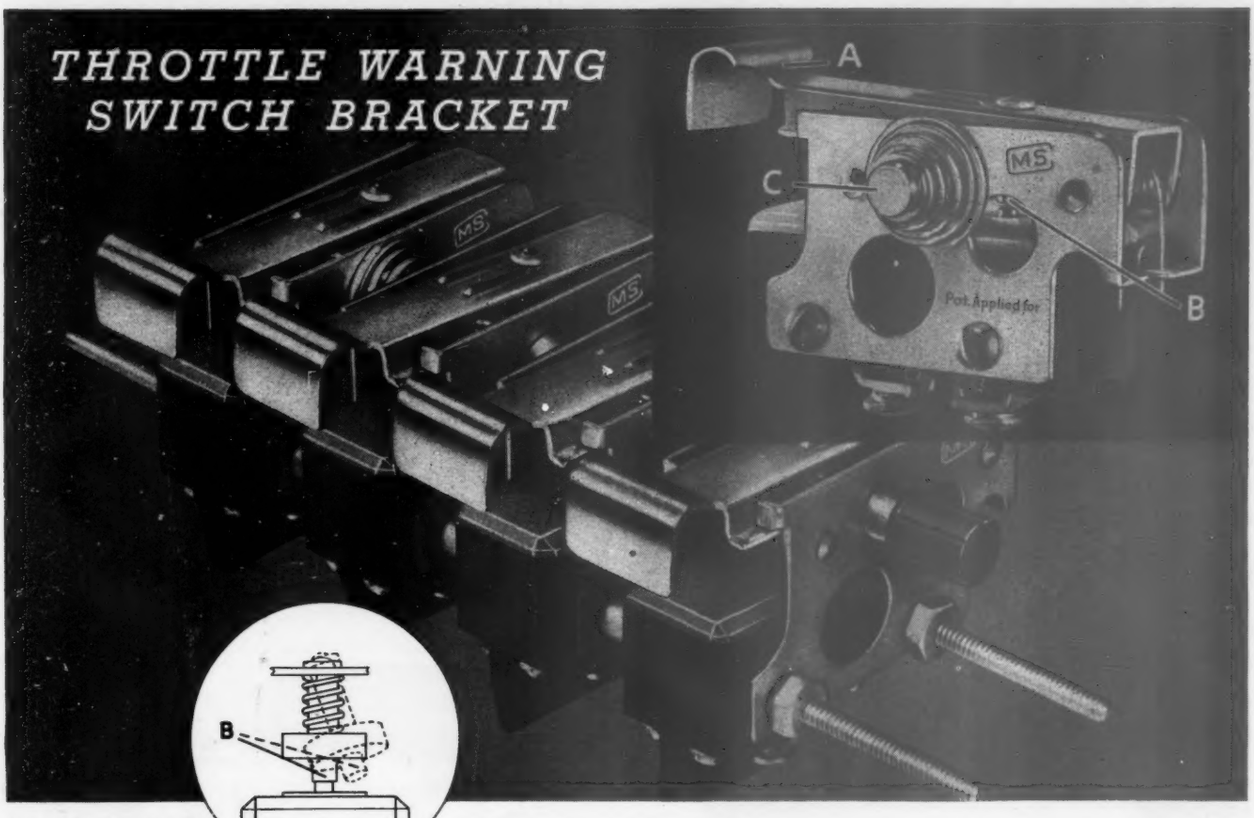

Inset at right shows how the spring mounted pin "B" is pushed aside by the reset rod.

The new Micro Switch throttle warning switch bracket with the standard Air Corps Approved Type 31 Micro Switch offers a light weight, easily assembled device for closing the warning circuit. Since the bracket is considered part of the aircraft, no deviation permit is required.

Retardation of the throttle moves the operating lever A downward by cam action. This actuates the Air Corps approved Micro Switch through the spring supported plunger B, thus closing the warning circuit.

If the circuit is to be opened with the throttle still retarded, the reset rod C is momentarily pushed, manually. This displaces plunger B as shown in dotted lines, and permits the Micro Switch to return to its open circuit condition. Upon next advance of the throttle, the spring carrying B returns it to its normal position ready to again operate the Micro Switch on next throttle retardation.

Only a small motion of lever A is required to operate the switch, and an equally small return motion of the leverA resets plunger B for the next cycle. Lever A may be overtraveled as much as ¼" beyond the point of switch operation.

The standard, single assembly may be conveniently ganged in two, three or four unit assemblies with operating levers on any desired centers. No close alignment is required. Reset of any switch or switches that may have been operated is accomplished by the one push control. When direct manual operation is not convenient, remote cable control can be used.

A sample of this bracket and Air Corps approved switch will be sent on request. Examination will demonstrate its light weight, simplicity, and adaptability to a wide range of mounting methods. The same device has been found useful for operations other than throttle warning control, and Micro Switch engineers are ready to cooperate on such applications.

New catalog No. 70 contains complete information about the characteristics, prices, and uses of Micro Switches for aircraft and aircraft accessories. Write for your copy.

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MICRO MS SWITCH

Manufactured in FREEPORT, Illinois, by Micro Switch Corporation. Sales Offices: New York, Chicago, Boston

Micro Switch is a trade name indicating manufacture by Micro Switch Corporation.

Maintenance Men

(*Continued from page 155*)

who have been restricted in their flying activity, have taken advantage of this opportunity to get their planes overhauled at low cost without concern for the time element involved. The school is therefore able to continue providing the students with actual operational experience which increases their stature for the important jobs they will be called upon to do in the nations vital commercial operational centers.

The accompanying photographs and captions describe, in part, the methods and facilities used in producing maintenance and service men for the Army and commercial flying services.

Airliner Air

(*Continued from page 161*)

Two position damper motor

Relay to close damper on fan shutdown

Two position steam valves for the tempering coil

Modulating steam valve on the main heating coil

Duct-stat set at 35 deg. F. controlling the steam valve supplying the tempering coil

Reverse acting pressure switch in steam main to close down fan in event of low steam pressure

High pressure cut-out on the Freon compressor

Solenoid operated water valve on the water line to the condenser.

Heating plant consisting of the following:

A flash type boiler operating at 75 to 100 lb. gauge pressure and capable of 360,000 Btu per hr. output. This boiler uses fuel oil and is complete with boiler feed pump, blower, and necessary equipment to make it full automatic in operation

A steam main supplying steam to heating coils in conditioning cabinets

Condensate return traps and main for return of condensate to receiver

A vented receiver to collect condensate and supply the boiler feed pump by gravity. This tank is equipped with a float control valve for make up water as required.

Rex-Flex elbow units for cabin heater conduit. 1½" I.D. with light weight adapter at one end and thick mounting flange at other.

Speed Up Assembly with REX-FLEX

STAINLESS STEEL FLEXIBLE TUBING

Rex-Flex Can Be Readily "Snaked" Into Place In Cramped Installations Such As Elbows and Sharp Bends, Eliminating Joints.

Aircraft manufacturers simplify many installation problems involving air ducts, blast tubes, radio shielding conduit, power plant accessory parts, oil and gas flexible lines by using Rex-Flex Stainless Steel Flexible Tubing. Extremely light in weight; bendable in multiple planes; obtainable in long lengths.

High Fatigue Value—
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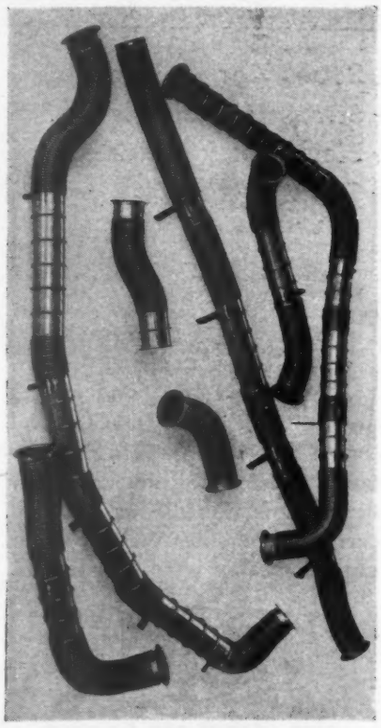
Rex-Flex Stainless Steel Flexible Tubing is available in five wallforms, all of which can be combined in a single one-piece length, with straight walls and corrugated sections at desired intervals. Sizes 5/16" I.D. to 5" I.D. incl. Made of 18-8 (Austenitic) Stainless Steel. Fittings are attached to tube ends by circular resistance welding.

No Flux, No Flame, No Quenching—Producing Absolutely Tight, Homogeneous Assemblies



Units Shown are Typical Vari-formed Assemblies.

Data and Engineering Recommendations on Request

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In Business Continuously Since 1869
32 Oregon Avenue, Philadelphia, Pa.

Good Neighbors

(Continued from page 55)

been ripped to shreds by the European holocaust. Normal sources of supply for many vital items were closed, and ordinary outlets for vast quantities of coffee, meat, hides, wool, rubber, tin, and many other products were closed by the blockade and shipping shortages.

AVAILABLE RAW MATERIALS

The loss of the supply sources in the Far East will make it imperative that the South American sources be tapped with all possible speed. Rubber and tin, which we had formerly obtained from Indo-China and the Dutch East Indies, are available from the forests and mines of Brazil, Bolivia, Peru and Central America. Manganese and platinum, formerly imported chiefly from Russia, are available in Brazil and Colombia. Copper, hides, chromium, nickel and tungsten can all be supplied from South American countries. We already have a large trade in such products as coffee, meat, nuts, tobacco, fertilizer, oil seeds, bananas, hardwood lumber, fresh and dried fish and many metals and minerals. During the war and after the war, this trade can be materially expanded. When the war is finished and we get back to the business of producing peacetime and consumer goods, we can find in South America ready markets for such American products as crude and fuel oil, gasoline, kerosene, machinery of all kinds, walnuts, furniture, building materials, electrical equipment and appliances of all kinds, industrial chemicals and many other items.

In all of this it is important for us to remember that there are 20 different countries in the Latin American trade area. These people must be understood by us if we are to do business with them. They are sharply divided by differences of race, language, climate, geography, and temperament. We cannot build our future commerce by following old textbooks or by sending the office boy down to negotiate our trade arrangements. This is a job for the boss and a job he must do first hand. And that means that he—many thousands of him—will have to pile into an airplane and go down for a personal study of the particular situation which interests him. As our western hemisphere trade expands, this problem will likewise increase and bring with it an inevitable tightening of the bonds between North and South America. We must bear in mind that most South American people are linked closely to Europe by ties of blood, culture and commerce. Our chief hope of modifying this picture to our mutual benefit is to make the fullest use of the airplane.

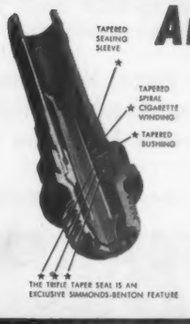
For example, we have arranged to publish a catalog in both the Spanish and Portuguese languages, listing the products of the Los Angeles area with directions as to how they may be obtained. This catalog is being sent to a select list of Latin American business men by air mail, and many of the products listed in the catalog will be shipped by air express.

VITAL ROLE OF AIR TRANSPORT

It can be seen then that the airplane is making it possible to establish the necessary contacts rapidly, and it is through this means that a firm foundation is being laid for future expanded trade. Air express is expediting the exchange of samples, commercial papers, and bills of lading, and the air mail is providing the means for the rapid interchange of vital information and business agreements.

It seems definitely within the realm of possibility, too, that many items of critically needed raw materials will be transported by air from South American reservoirs of supply to the United States. South America has been the proving ground for air freight, and such opera-

SIMMONDS-BENTON *AIRCRAFT* POWER PLUG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TAPERED SPIRAL CIGARETTE WINDING
TAPERED BUSHING
THE TRIPLE TAPER SEAL IS AN EXCLUSIVE SIMMONDS-BENTON FEATURE

Another "Solo"... *"Alone in the air"* is the Simmonds-Benton Power Plug — the *only* plug with ★★★ Triple Taper Seal. Note the *tapered* sealing sleeve, *tapered* spiral winding, and *tapered* bushing — for dependable performance under the toughest conditions. Interchangeable-replaceable part construction is another Simmonds-Benton feature, making thorough inspection easier and quicker, lengthening useful life.

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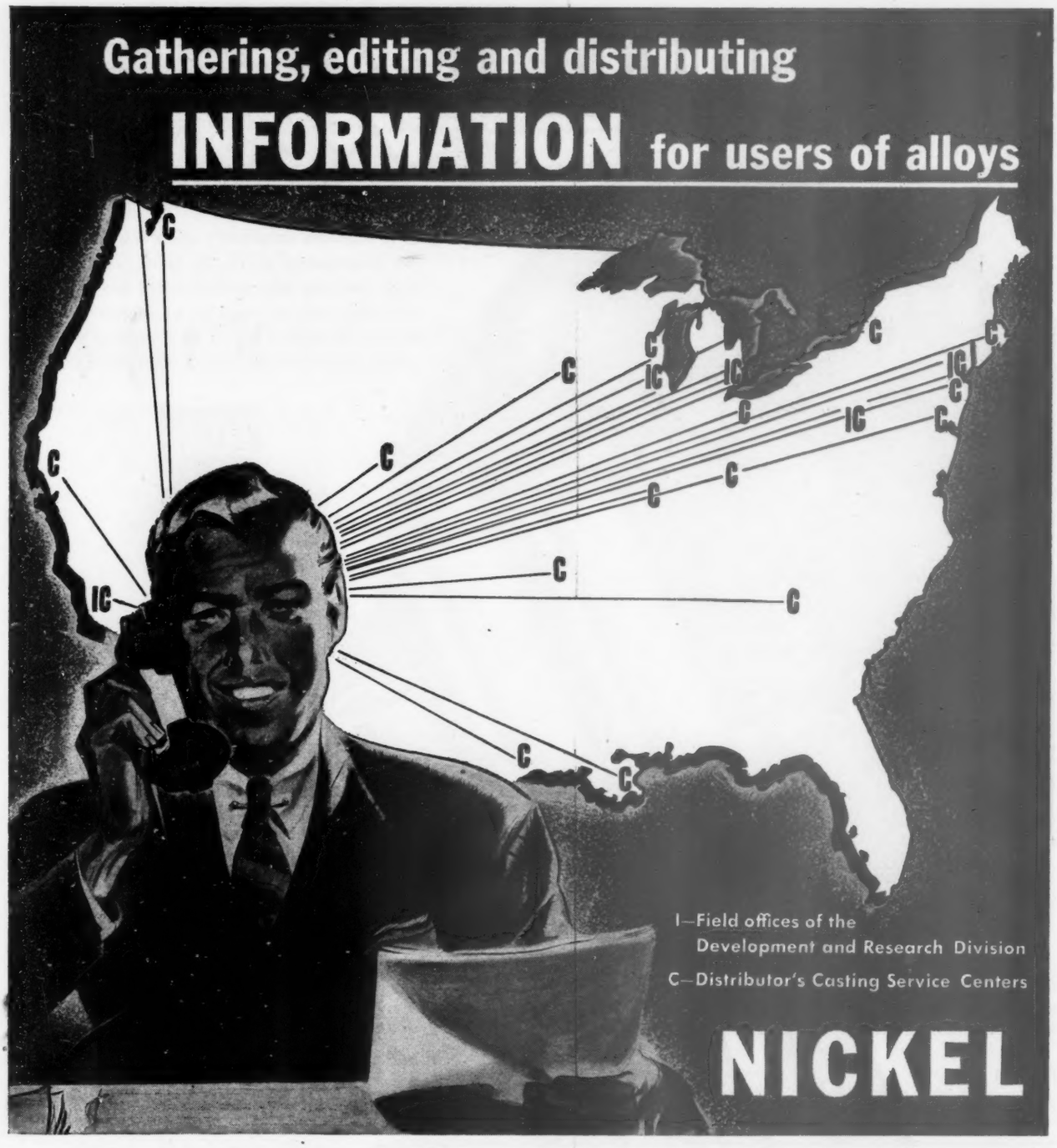

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tions have been conducted on a rapidly increasing scale for many years. To date, most of the cargo has consisted of finished products and livestock, but with time of the essence, it seems certain that great shipments of raw materials will be transported by air. As a result, an entirely new concept of trade relations with our neighbors will be established.

Aviation is giving us the means by which to make the most of our golden opportunity to become mutual customers and business associates. Once we have established trade relations, we should be able to rely upon the American tradition of the square deal to build a foundation of good will for Western Hemisphere business, political, and social solidarity that will set an example for a world determined to achieve a democratic peace.

Book Review

(Continued on page 194)

If one ever had any difficulty in committing to memory the various cloud formations and their names, he will find in this book a simplified glossary supplemented by a splendid collection of cloud paintings. Mr. Sloane has done with his brush what St. Exupery did in writing to bring to the realer a sensitive and appreciative glimpse of the flyer's element.

After closely examining the origin and characteristics of the various cloud formations, the author describes by means of well chosen text and cartoons, the origin of "weather," its measurement, and its presentation in the form of weather maps for the guidance of pilots. Scattered throughout, the pilot-reader will find many pertinent tips on how to conduct himself in flight through various weather conditions.

WINGS OF DEFENSE, *by Captain Burr W. Leyson. Published by E. P. Dutton & Co., Inc., New York. Illustrated, 210 pages, $2.50.*

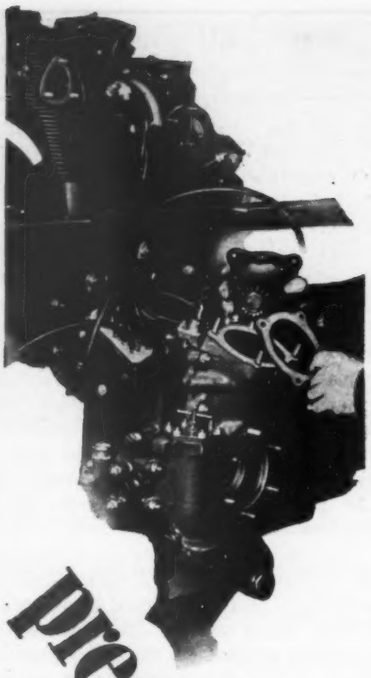
For the layman just awakening to the airplane's vital place in world affairs, this book gives an excellent sketch of the types of planes employed by both land and sea forces, together with an outline of the facilities needed to provide the planes and the men to fly and maintain them. In almost every case, today's ships and their functions are explained against a background of the lessons learned in World War I, when Captain Leyson was fighting as a pursuit pilot.

Of particular value is the explanation of the tremendous problems surrounding expansion of production.

In addition to the chapters on fighters, bombers and naval aircraft and their functions, the book also traces the development and paratroops and bombing. The oft-criticized educational requirements for Army and Navy pilots are defended in the chapter on pilot training, which sketches the development of both equipment and the kinds of flying necessary in modern warfare.

WOMEN WITH WINGS, *by Charles E. Planck. Published by Harper & Brothers, New York. 333 pages, $2.75.*

"Seven months after the first man flew, the first woman flew. In 1804 Napoleon named a woman his Chief of Air Service." That's the way Mr. Planck's book starts, and it stays just as good all the way through such chapters as The Hands That Rocked the Crates, Well—A Woman Taught Me to Walk, With Plane and Helmet Through the Public Prints. It sounds, and is, positively amusing, because the author is an irrepressible light-heart, but actually the book is loaded to the critical point with sound information.



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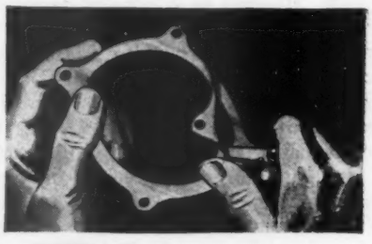

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Based on a proven design that has seen years of service in European Aircraft, the Olaer Accumulator is now being offered by Simmonds for use in American Aircraft. . . . Simple in construction, the Simmonds Accumulator is built to eliminate expensive and troublesome maintenance. This, plus its low initial cost makes it an extremely economical and efficient unit for use in aircraft Standard Pressure Hydraulic Systems.

In case of pump failure, the reserve power stored by the unit can be called upon to operate every hydraulic device on the plane at least once, and to operate the power brakes a sufficient number of times to insure a safe landing. *For detailed information, write:*

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Altschul

(Continued from page 149)

slightly more than $4,000,000 annually. This amount looks rather picayune when compared to the earnings of most any single industrial company of national importance. Further, only a few air carriers have thus far demonstrated any real earning power—American, Eastern and Northwest.

The proposed tax measure together with disquieting war developments were primarily responsible for most of the air transport securities breaking to new lows for almost three years and in many instances perilously close to the bottom levels established during 1938 and 1939. The general market, of course made new lows as well.

Eastern Air Lines, for example, during 1941 and early 1942, while "heavy" at times, repeatedly refused to penetrate $24 per share one the downside. While a certain amount of weakness was induced by the examiner's report recommending reduced mail compensation, it was the tax and war news which first swept the supports away with the stock breaking badly through its old resistance level.

Similarly, American Airlines, in the face of an excellent earnings report, broke through its previously established resistance level of $40 per share. The special stock offering of 93,769 shares and the subsequent CAB decision further pounded the stock to a new low.

NORTHWEST STOCK STRONG

The strongest acting airline security, has been Northwest Airlines, Inc. While listed on the New York Stock Exchange for only slightly more than a year, the stock has given an excellent account of itself. At one time, United Air Lines, TWA and Penn-Central all sold at higher levels than Northwest. Today, this is no longer true. This favorable action may be attributed to a genuine earnings record on the part of the company. There is also considerable "romance" attached to Northwest in terms of possible new routes. The company's application for a route to Alaska has come in for considerable discussion in view of that area's importance. Northwest also has fiscal year benefits, its yearly books being closed on June 30. This should delay the effect of any new taxes imposed by a full year.

While most of the major airlines (American, Eastern, United, TWA and Penn-Central) report on a calendar year basis, the bulk of the smaller air carriers close their yearly accounts on a fiscal basis, usually at June 30.

Returning to the American Airlines offering provides an interesting sidelight. It must be noted that this transaction represented no new financing for American. This stock came from the Aviation Corp. which received a total of 193,769 shares upon converting American Airlines debentures at July 1, 1941. At that time there was some question as to the legality of Aviation Corp. being permitted to hold this stock without approval of the CAB.

Under Section 408 of the Civil Aeronautics Act of 1938, it is unlawful unless so approved for "any person engaged in any other phase of aeronautics to acquire control of any air carrier in any manner whatsoever." As Aviation Corp. has long been identified with aircraft manufacturing properties. (Vultee, for one), a conflict with the statute appeared possible.

This provision of the 1938 act retained a principle of the Air Mail Act of 1934 separating any interests existing between an air mail contractor and an aircraft manufacturing company. It was this provision which, in early 1938, finally led North American Aviation Inc., to dispose of Eastern Air Lines.

Aviation Corp. solved its dilemma by depositing its American Airlines stock with Jesse Jones, as trustee. Provision was made for the termination of this trust at any time during its specified life, by the sale of the trust certificates by Aviation Corp., in which event the new holders could surrender their trust certificates and receive the actual stock from the trustee. At the time of this agreement, there was good reason to believe that Aviation Corp. was strongly disinclined to dispose of its American Airlines stock.

Now, about eight months later, in a surprise move Aviation Corp. decides to sell half of its American Airlines holdings. This move brings its present investment in the airline to about 18 percent of the outstanding common stock. This still leaves Aviation Corp. as the largest single stockholder in American Airlines and may be construed in the eyes of the CAB as the controlling factor. Under such circumstances, it would not be very surprising if the remaining 100,000 shares of American now held by Aviation Corp. were to be sold in the near future.

SHIFT TO MANUFACTURING

Why this evident sudden departure from the air transport industry by Aviation Corp.? This action may not only obviate any possible future conflict with the CAB, but may represent another phase in the broadening of interest in aircraft manufacturing by Aviation Corp. Early this year, Aviation Corp. caused Vultee Aircraft, which it controlled through a 71 percent stock ownership, to acquire control of Consolidated Aircraft Company. Ultimately, it is proposed to merge both aircraft properties under one corporate structure.

This constant shift to manufacturing by Aviation Corp. is similar to the pattern pursued by General Motors Corp. many years ago.

There are two phases to aviation—manufacturing and transport. Experience indicates that in the long run the manufacturing end of any transportation generally is the more profitable—or at least easier to manage. This line of reasoning is clearly evident when the intricate threads of General Motors' ten years of endeavors in aviation are unspun. Almost forgotten is the one-time interest by General Motors in TWA along with complete ownership, through North American Aviation, of the company now known as Eastern Air Lines.

General Motors sold its TWA in 1935, and ever turning to manufacturing in preference to air transportation activities, caused the properties representing Eastern Air Lines to be sold in 1938. Such sales not only avoided possible conflict with the Air Mail Act of 1934 but also permitted General Motors to concentrate in that phase of aviation it preferred and where it considered the best profits to be—in manufacturing.

Similarly, the properties in the Aviation Corp. orbit may now be submitting to a rearrangement so that complete concentration may be devoted to manufacturing and where all possible resources may be required.

Certainly, Aviation Corp., in retrospect, did not employ the most favorable timing in the disposal of its American Airlines stock. During 1940, this stock sold as high as $75 per share. While Aviation Corp. owned American Airlines debentures at that time, such securities were convertible into common stock at that period and could have been sold in that manner if so desired. In any event, Aviation Corp. realized a profit of about $2,400,000 on this transaction which will be subject to a normal income tax of at least 24 percent. Moreover, if it is intended to sell the remaining 100,000 shares, it is likely more propitious markets will be awaited.

Aviation Corp. also owns 183,477 shares or about ten percent of the outstanding common stock of Pan American along with investments in New York Shipbuilding and Auburn Central.

It is in Vultee, however, that Aviation Corp. has staked its destiny. As part of the Consolidated deal, Aviation Corp. purchased an additional 150,000 shares of Vultee common stock, bringing its interest in that company to 902,168 shares or about 85 percent of the outstanding common stock. When Vultee and Consolidated are ultimately merged, Aviation Corp may be in control of what may turn out to be the largest aircraft manufacturing enterprise under one corporate structure.

IN WAR AS IN PEACE
EDO STANDARD FLOATS MEET EVERY TEST

For 17 years the Edo organization has applied itself to the building of all-metal seaplane floats. Early it was recognized that the production of float gear to the highest engineering standards would claim the full energies and technical skill of an entire organization—research, engineering, manufacturing and flight testing.

Holding to its special field, Edo has kept pace, step by step, with aviation's far-reaching advances. Today Edo floats are not only the most numerous in service but are recognized as "standard the world over"—unsurpassed for efficiency in the air and on the water.

No greater proof of the inherent soundness of Edo design and construction could be asked than the simple fact that standard "commercial" Edo Twin Float installations—without modification—are now capably serving on naval and military aircraft of the United States and allied nations.

If you are a civilian pilot—in CPTP training, on CAP duty, or serving in other ways—you may equip your plane with standard Edo Floats with the knowledge that better floats are not made. For details, write Edo Aircraft Corporation, 402 Second St., College Point, L. I., N.Y.

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North American O-47A—U. S. Air Force
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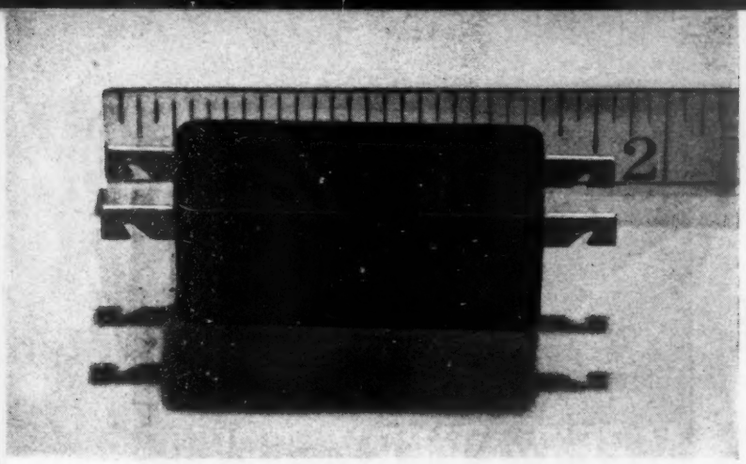
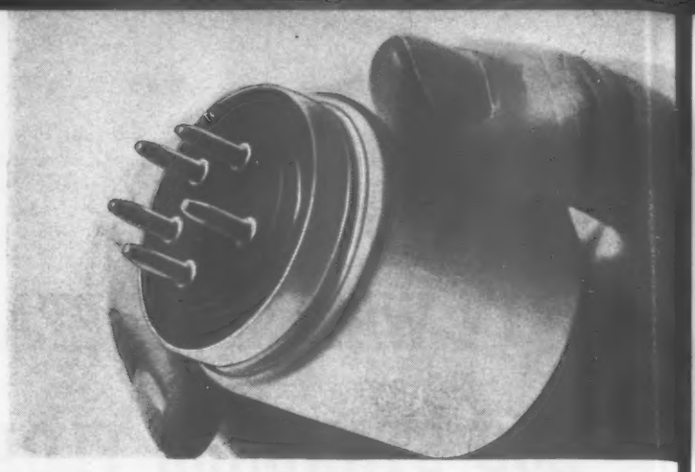
Ryan Trainer—N. E. I. Navy
Stinson (Civilian)
Vultee O-49—U. S. Air Force

EDO Floats

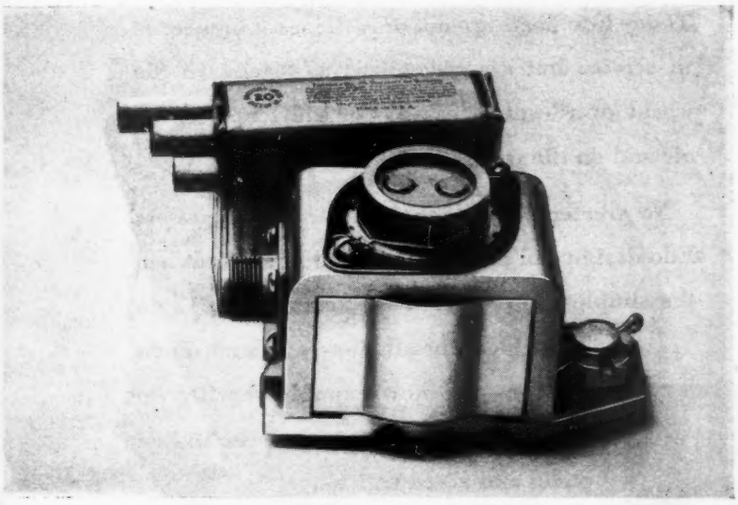
STANDARD THE WORLD OVER



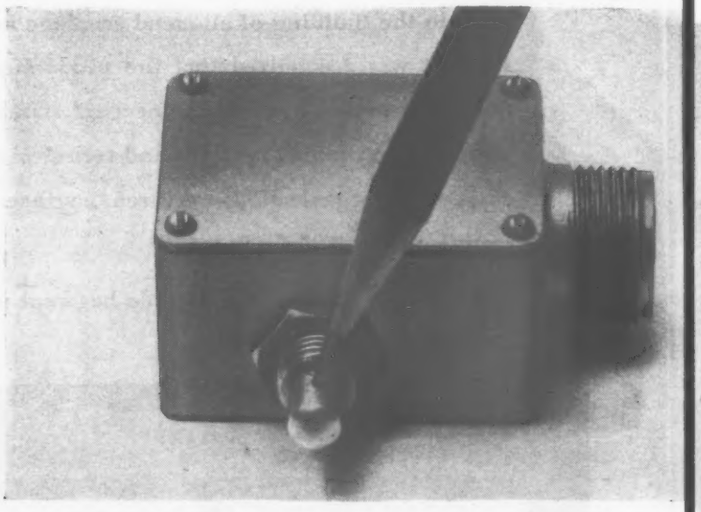
G-E Switchette Weighs 9 grams; measures 1¾ in. x ½ in. x $\frac{19}{32}$ in.; comes in either single-circuit or two-circuit form, and provides one normally open or one normally closed contact, or both one normally open and one normally closed contact; has double-break contact construction. See Bulletin GEA-3818 for further information.



Sensitive D-C Relay Weighs 3¼ ounces; has a maximum continuous rating of 2 amperes at 32 volts, d-c, and a maximum make or break rating of 10 amperes; provides single-pole, double-throw contact arrangement. Sealed aluminum cover protects relay from dust and against damage from rough handling. Detailed description in Bulletin GEA-3819.



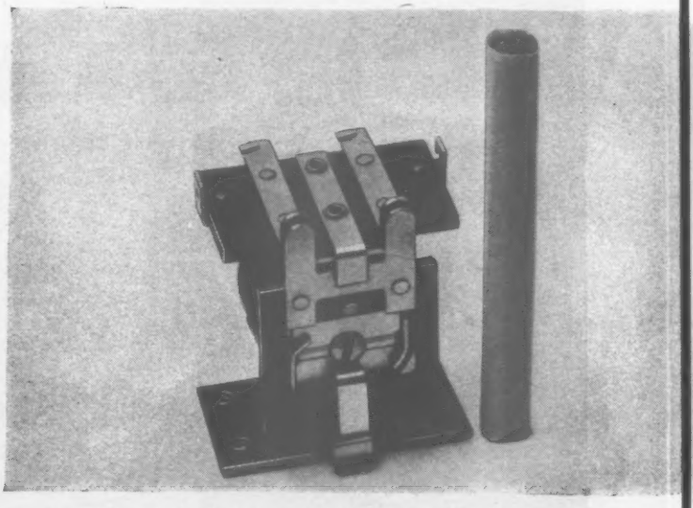
Aircraft Solenoid (Type G-9) Weighs 2.1 pounds; operates on 4.3 amperes at 24 volts, d-c, in 20 C ambient temperature. Built to meet U. S. Government specification. Complete details given in Bulletin GEA-3820.



Limit Switch Weighs 2.15 ounces; contact mechanism is the G-E switchette; has 7/32 in. overtravel; measures approximately 2⅜ in. x 2 in. x 1⅛ in. For full information about this sturdy, aluminum-housed limit switch, see Bulletin GEA-3821.

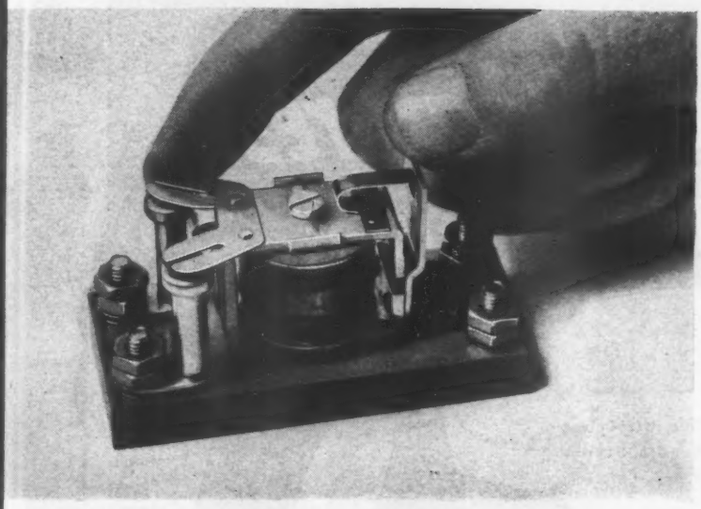
G-E Aircraft Controls Meet These U. S. Govt. Requirements

1. Navy 200-hour salt-spray test
2. U.S. Govt. vibration stipulations
3. Operate at rated current up to 40,000 feet altitude
4. Withstand linear acceleration of 10 G applied in any direction
5. Operate at temperatures from −40 C to 60 C or 95 C

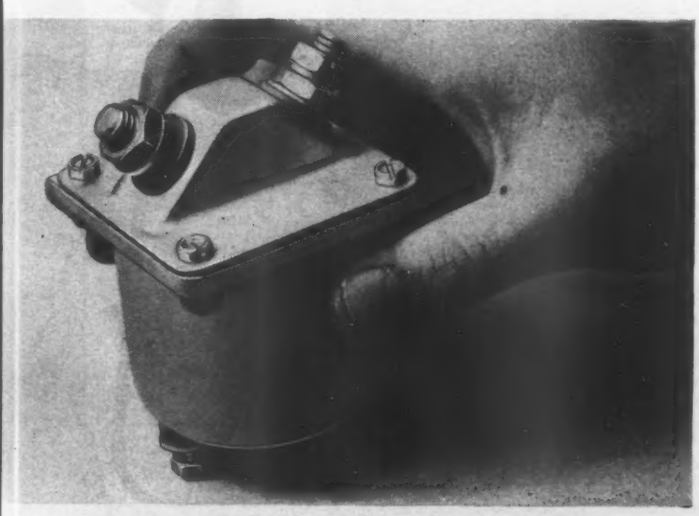


Single-pole Relay Weighs 3.7 ounces; has a maximum continuous rating of 20 amperes at 12 or 24 volts, d-c; provides one normally open, or one normally open and one normally closed contact. Two-pole and three-pole forms of this relay are also available. Bulletin GEA-3813 gives complete details.

General Electric *now offers* Aircraft Controls



Single-pole Relay Weighs 6.1 ounces; has a maximum continuous rating of 25 amperes; at 12 or 24 volts, d-c, and a maximum make or break rating of 100 amperes; provides one single-pole normally open double-break contact. Detailed description in Bulletin GEA-3815.



Dynamotor Contactor Weighs 2.3 pounds; operates on 12 or 24 volts, d-c; handles an inrush of 500 amperes at 28 volts; provides one single-pole normally open contact; has a 50-ampere rating based on the NEMA 8-hour test. Bulletin GEA-3812 gives full information.

General Electric announces a line of control devices for aircraft electric systems. Most of the devices shown here are already in production; others will be shortly. Our Research Laboratory, our designers, and our manufacturing organization are pledged to meet the rigid standards of today's fighting ships.

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A new and fast-moving industry calls for the development of many new electric products. We invite you to bring your special control problems to our *Industrial Control Division.* Its engineers will gladly discuss with you the design of new electric control devices to meet your needs.

For bulletins listed under pictures, or for information about the design of new products, write *Section 676-72, General Electric Company, Schenectady, N. Y.*

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GENERAL ELECTRIC

676-72

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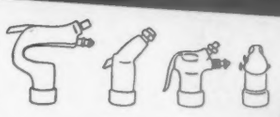
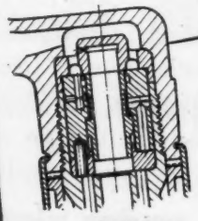
IN THOR'S great lineup of "Speed Features" you find the way to fastest riveting. You get the hard hitting power, the sensitive control, and the small size and weight so vital for top speed schedules. Especially designed for aircraft work, these THOR slow hitting riveting hammers are available in thirty-five models for fastest driving of aluminum, dural, and soft iron rivets. For full details and specifications, send for the THOR Airplane Tool Catalog.

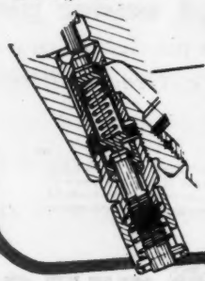


Five Different Handle Styles

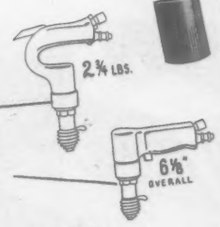
Thor Slow Hitting Riveting Hammers Give You . . .



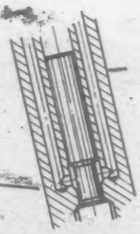
Hard Hitting Power! The THOR Sleeve Type Main Valve insures a slow, hard hitting blow. Instead of drilled ports, the varying diameters of the valve provide for opening and closing of ports. The large bearing surface retains lubrication, makes leakage and loss of power through this valve impossible.



Sensitive Control! The THOR Air Regulator enables the operator to increase or decrease the supply of air to the hammer according to job requirements without affecting throttle valve control. Thus, with regulator adjustment and trigger control, he can strike as few as one or two blows when needed.



Extra Light Weight! THOR design provides the minimum size and weight for quick, accurate operation. These hammers weigh as little as 2¾ lbs., are as short as 6½". Five handle styles — grip, pistol, lever, offset and button — meet every operating condition.



Sturdy Construction! In the THOR barrel the bore is ground and lapped to a smooth finish to insure a sealed fit with the piston. The result is highly efficient service and sustained uniformity of power over a long period of service.

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★ All American fighting planes have one important feature in common: their engines are designed for high-octane gasoline. That's the basic reason why they have more power than similar enemy planes. And because they have more power, they will—plane for plane—outfly and outfight our enemies'.

We alone have *all three* things needed to produce high-octane gasoline—and plenty of it: *one*—vast resources of high quality crude oil; *two*—superior refining processes, developed by America's petroleum industry; *three*—adequate production of anti-knock fluid to improve octane ratings of military gasolines.

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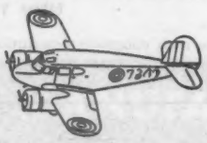
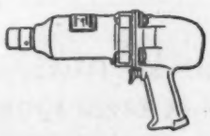


CESSNA AIRCRAFT COMPANY

LIGHTNESS IN WEIGHT



Light weight and small size in proportion to power rating are outstanding features of air-operated portable tools. Compact, high-capacity Needle Bearings aid in attaining these desirable features in this impact wrench manufactured by Ingersoll-Rand Company.

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5. Cutting an External National Fine Thread

5 ON THE MILLING MACHINE

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2. Cutting Keyways
3. Straddle and Surface Milling to Close Tolerances
4. Straddle Milling
5. Plain Indexing and Cutting a Spur Gear

3 ON THE VERTICAL BORING MILL

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2. Rough Facing and Boring and Turning a Shoulder on a Vertical Turret Lathe
3. Facing, Turning, Boring, Grooving, Chamfering on a Vertical Turret Lathe Using 2 Heads

5 ON PRECISION MEASURING

1. The Steel Rule
2. The Micrometer
3. Fixed Gages
4. Vernier Scale
5. Height Gages and Standard Indicators

3 ON THE SHAPER

1. Cutting a Keyway on End of a Finished Shaft
2. Machining a Rectangular Cast Iron Block
3. Machining a Tool Steel V Block

2 ON THE RADIAL DRILL

1. Drilling and Tapping a Cast Steel Valve Body
2. Drilling and Spot Facing a Cast Iron Valve Body

10 SUBJECTS ON SHIPBUILDING!

THESE 17 TITLES WILL BE RELEASED SOON:

- 5 On Bench Work
- 5 On Bench Work and Centering
- 2 On the Lathe
- 1 On the Sensitive Drill
- 2 On the Vertical Drill
- 2 On Action of Single-Point Cutting Tools

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When the time finally comes chocks are withdrawn and the twin engines roar into exultant crescendo for the take-off, a small gang of men in oil-smeared overalls will be watching with approving, confident eyes from the shadow of the control - tower. Those men are the 'fault-finders,' and their job is a vital one. Check, test and counter-check. Everything must be just **right.** The safety and efficiency of the ship is only gained by long hours of unremitting toil.

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how to use them
how to test them
how to repair them
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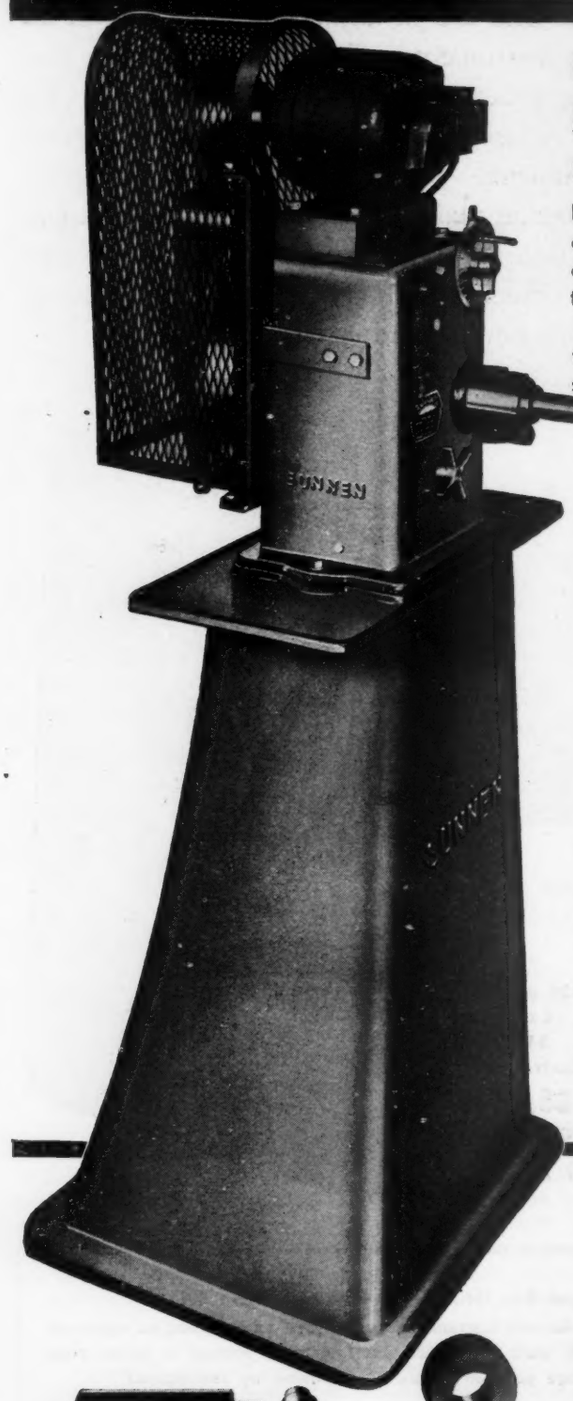
DON'T THROW AWAY YOUR BROACHES or REAMERS Because they are a LITTLE UNDERSIZE



Use the SUNNEN "MA" Precision HONING MACHINE to take out that Last Thousandth or so . . .

Reamers and broaches are expensive — and hard to get! Don't discard them simply because they are a little undersize. Go ahead — use them as long as you can — and remove that last thousandth or two with the Sunnen "MA" Precision Honing Machine.

Leading defense manufacturers the country over are using this inexpensive machine to accurately finish internal cylindrical surfaces from .185" to 2.400". Accuracy within .0001" is guaranteed and has often been held to .000025" in production work.

Solves Five Important Problems

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2. Produces super-smooth surface finishes.
3. Accurately finishes holes to very close tolerances both as to size and straightness.
4. Maintains alignment already established by previous operations.
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Write for FREE Bulletin

giving complete information and showing many examples of use. Or if you prefer, we'll have a sales engineer call and demonstrate this equipment in your plant, on your job.

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Molded Composition (Bakelite) Pulleys. Molded composition is a difficult material to machine but it can be easily honed to a smooth finish.

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TYPE AVR-101

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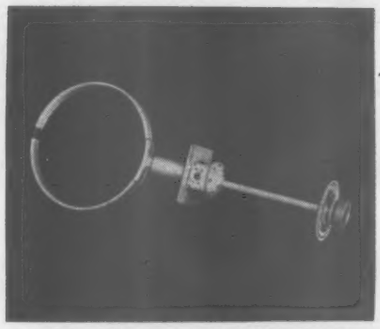

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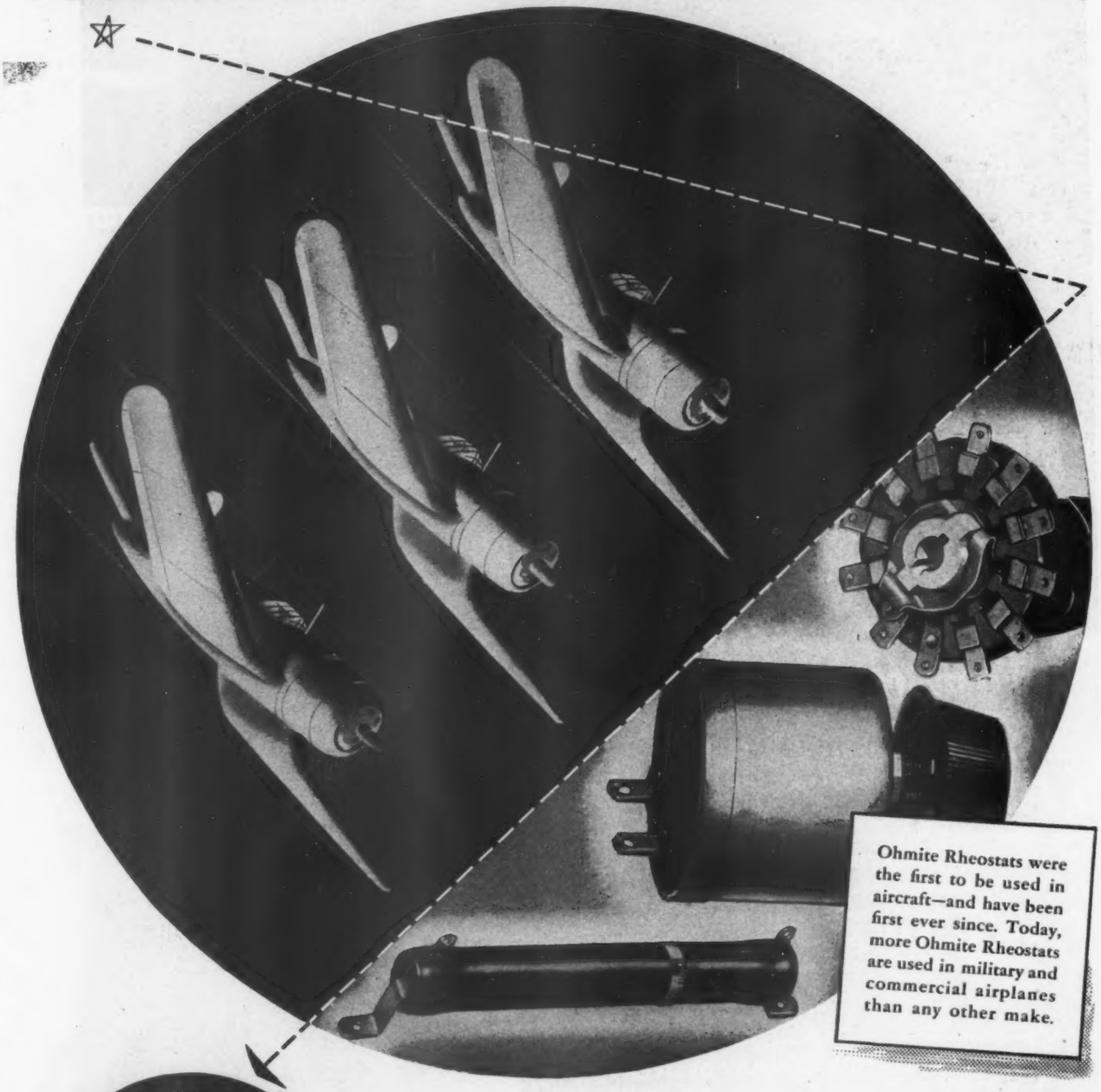

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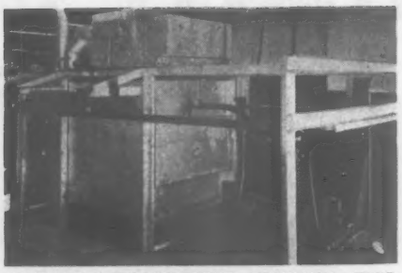

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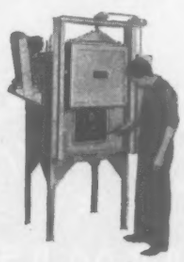

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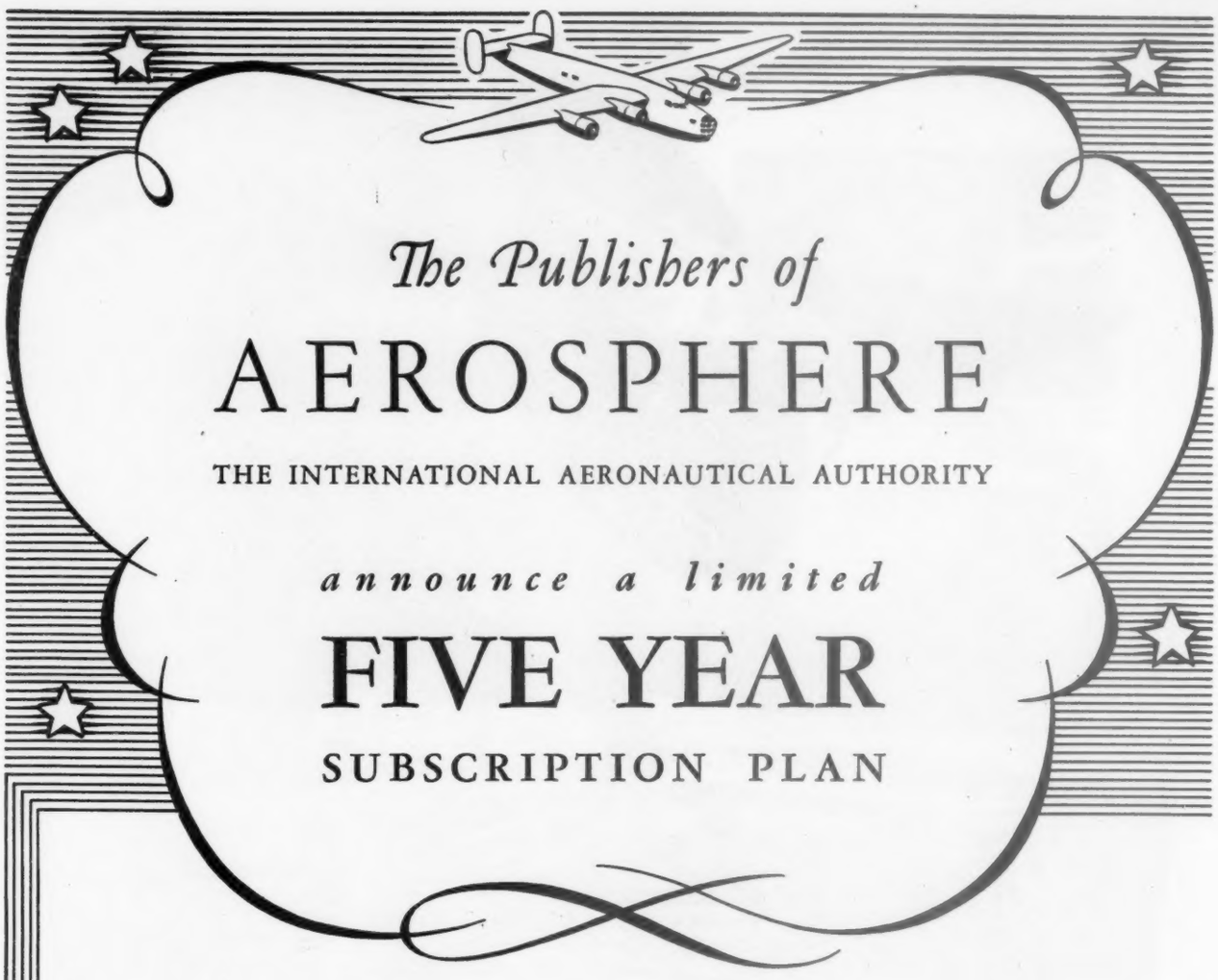

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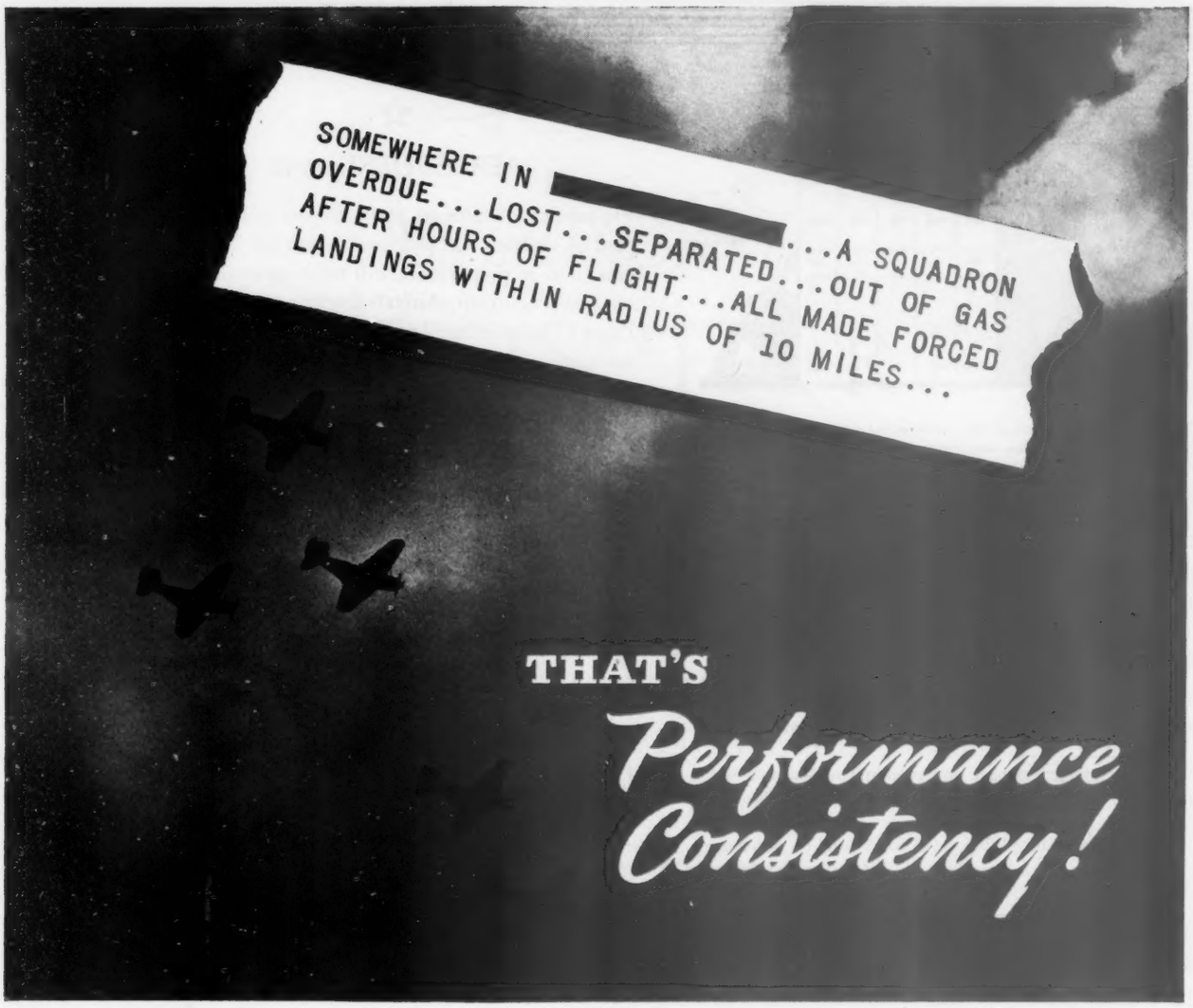

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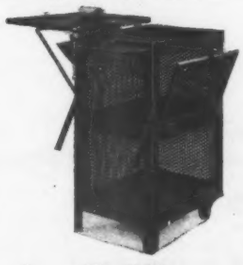

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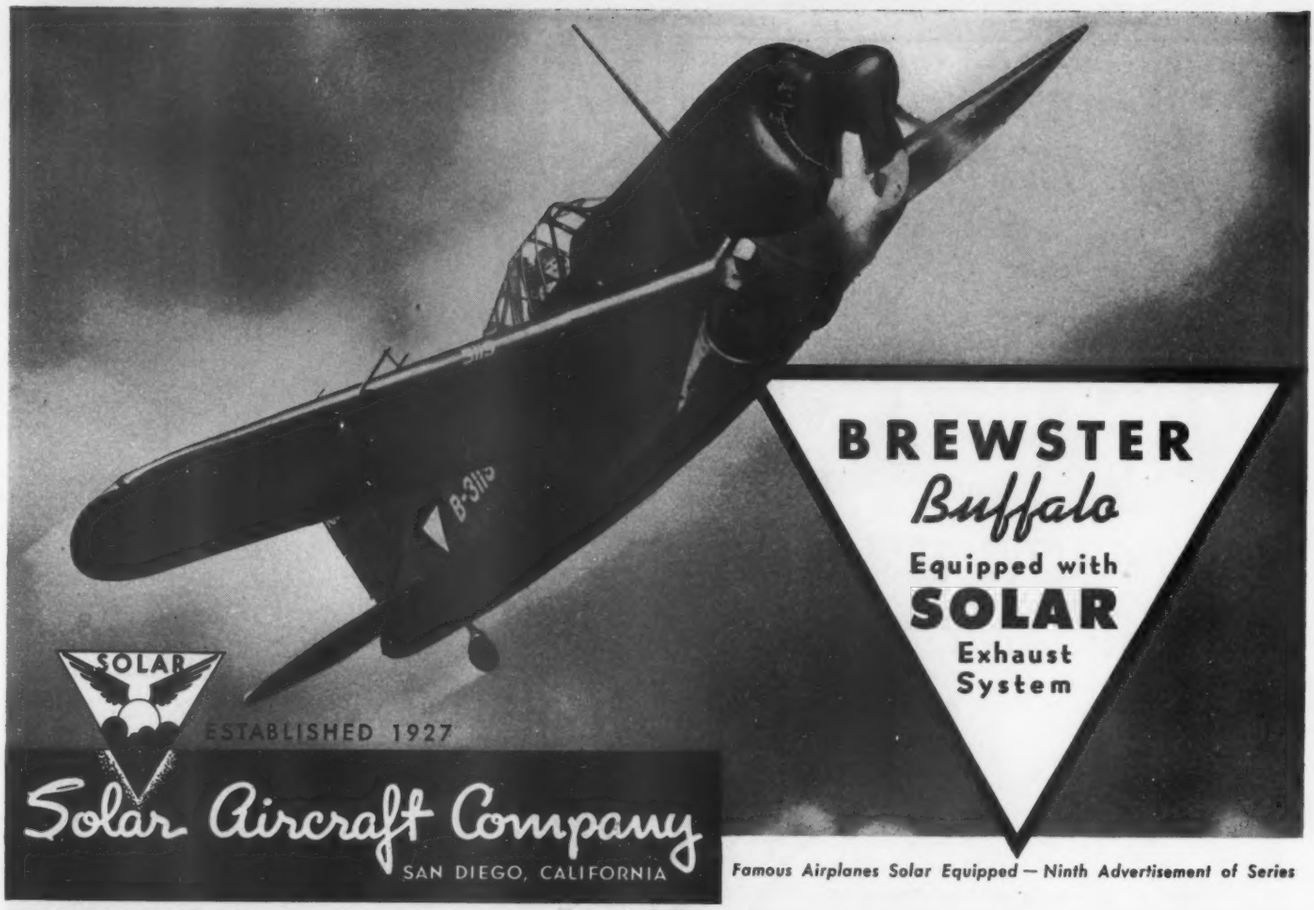

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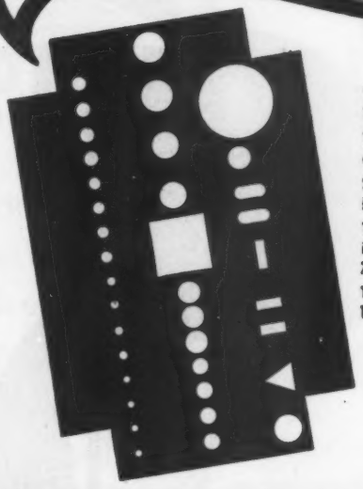
MAKE 3 PIECES AS SHOWN



12 gauge (.109) mild steel 18" x 24".

16 different dies used, requiring 16 turret positions

Set up time—5 minutes, 6 seconds

Time to pierce 41 openings including turret rotation—7 minutes, 24 seconds

Time to produce first piece—12 minutes, 30 seconds

WITH WIEDEMANN TURRET PUNCH

12½ MINUTES—FOR 1st PIECE

7½ MINUTES—EACH FOR 2nd AND 3rd PIECES

The almost unbelievable fact is that this one job—from blank to finished piercing—took just 12½ minutes—the result of the time saving Wiedemann Gauge Table and Turret Punch Press.

The material is handled to predetermined positions by the operator—Turret construction makes required die instantly available—and the press pierces the material—accurate to ± .007".

There is a size and capacity for every use—Short run jobs can be produced at long run low cost. Be sure to write for full details on the models and types of Wiedemann Turret Punches. Get the proof of short run piercing efficiency.

WIEDEMANN MACHINE CO.
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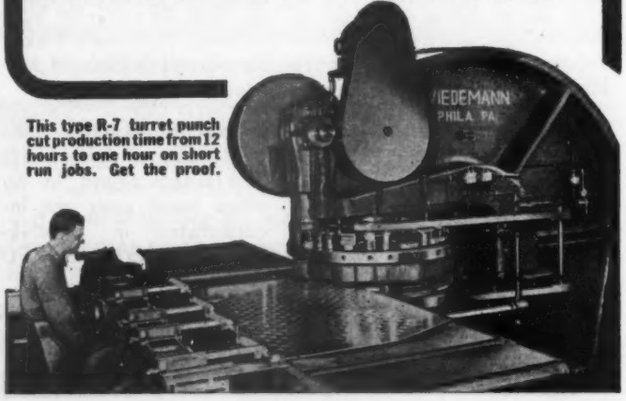


This type R-7 turret punch cut production time from 12 hours to one hour on short run jobs. Get the proof.

Tannewitz
HIGH SPEED BAND SAWS

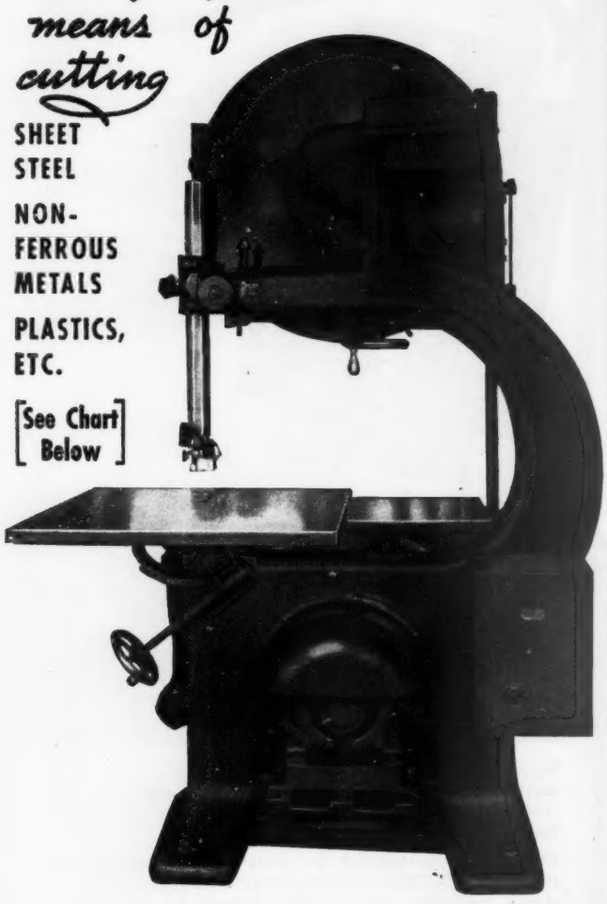
A far faster means of cutting

SHEET STEEL

NON-FERROUS METALS

PLASTICS, ETC.

[See Chart Below]



These superb machines, built to deliver any speed up to two miles of saw blade travel per minute without vibration, are doing hundreds of metal-cutting and other jobs in a fraction of the time previously required, in plants throughout the aviation industry. To increase production and make important savings in costs by all means investigate them, at once. A line requesting Metal Cutting Band Saw Bulletin will bring you the complete facts promptly.

PERFECTLY SAFE: Two-Wheel Lockheed Hydraulic Brakes automatically and instantly stop the wheels in case of saw blade breakage—completely guarded.

KIND OF MATERIAL	Thickness and speed for sawing of sheet: 1/32	1/16	1/8	3/16	1/4	1	2	3
Mild Steel	12-24	6	3	1				
Stainless Steel	6	2	1					
Yellow Brass, Zinc	24	12	6	3	1½	½	⅜	⅛
Bronze or Copper	6	3	1½	¾	⅜	⅛		
Aluminum	24-36	18	9	4½	2	1½	1	⅜
Duraluminum	24	12	6	3	1½	1	½	¼
Sheble Plymetal				6	4			
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Plywood	24-36	24	20	16	12	6	3	1½
Asbestos Board	12	6	3	1½	¾			
Fibre (Hard)	24	12	6	¾				
Paper Board	24	18	12	4	2	¾		
Masonite	24	18	12	6	3	1½	¾	⅜
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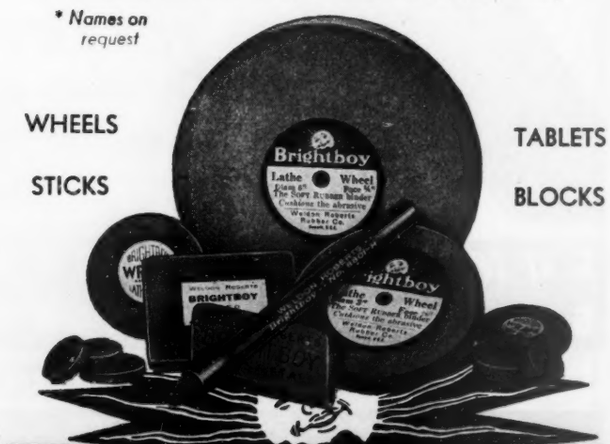

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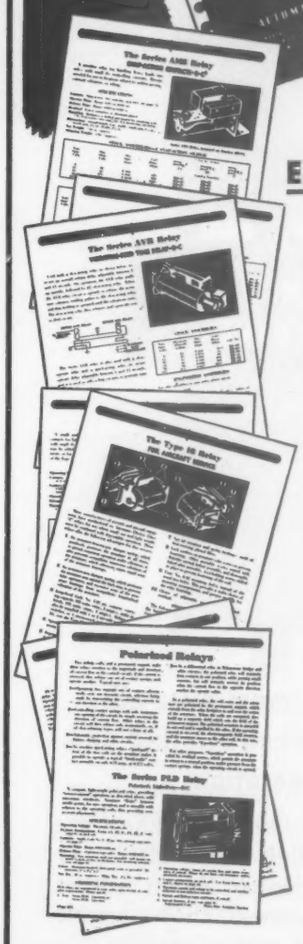

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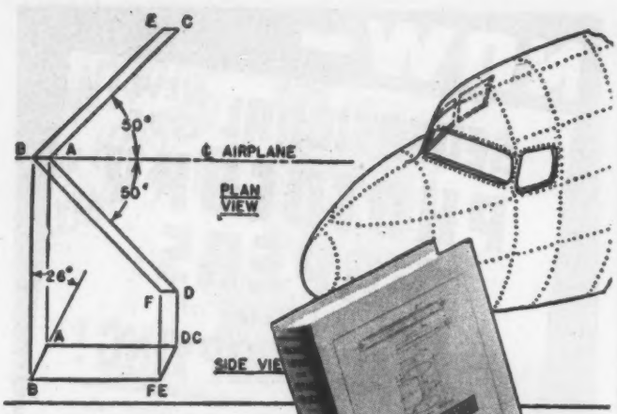

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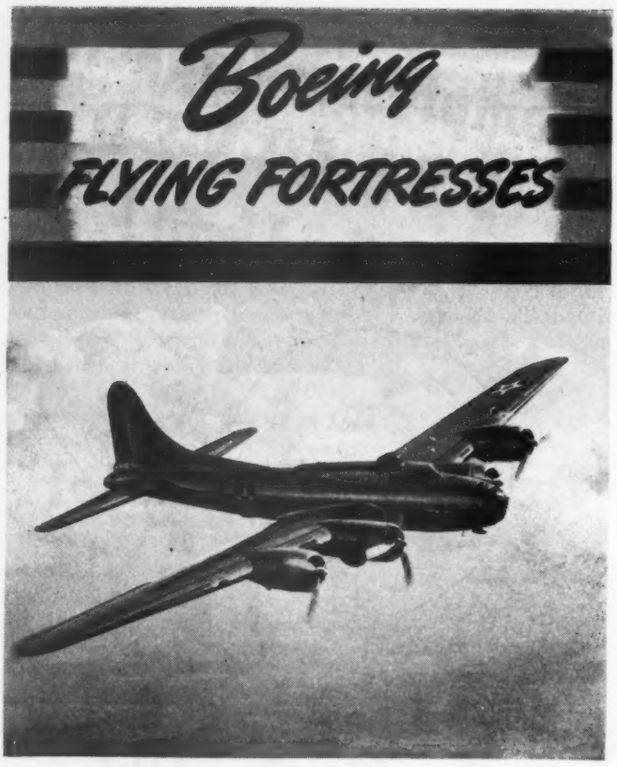

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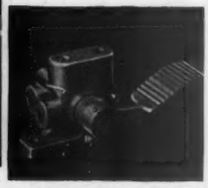

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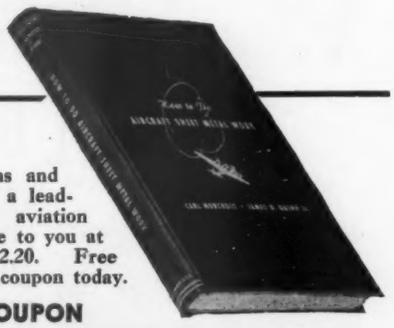

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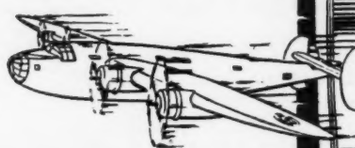

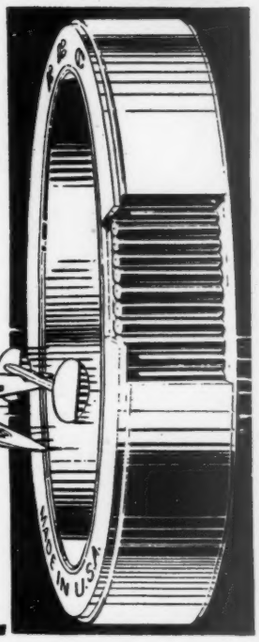

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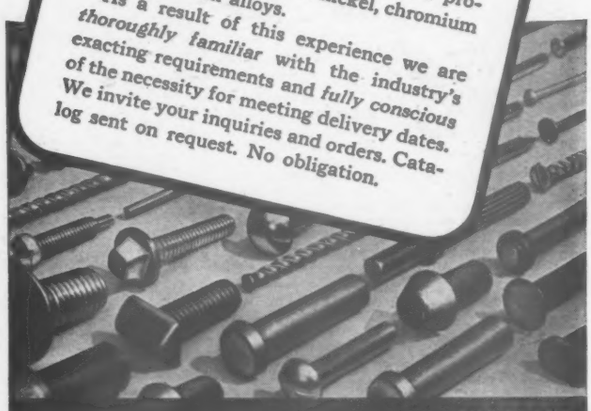

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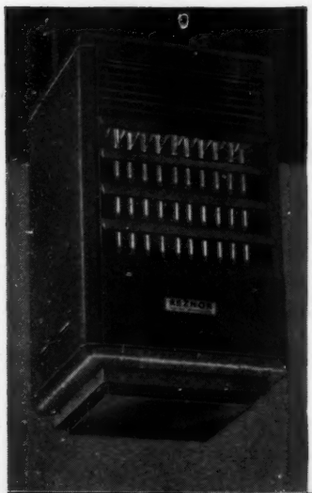

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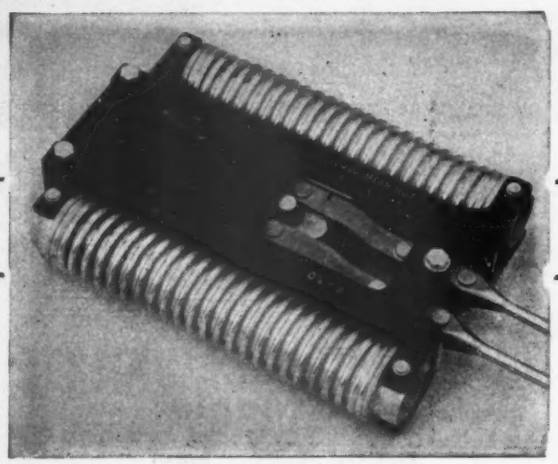

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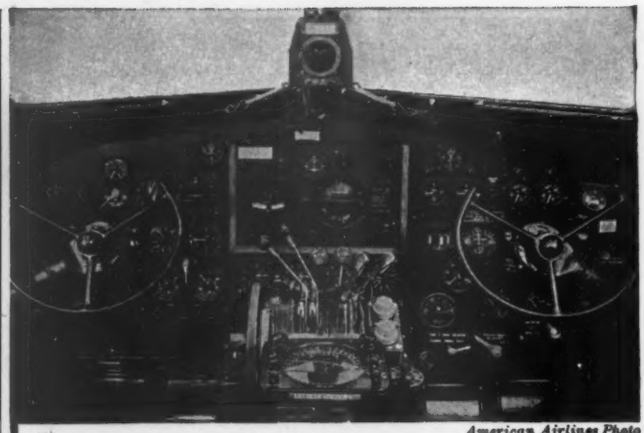

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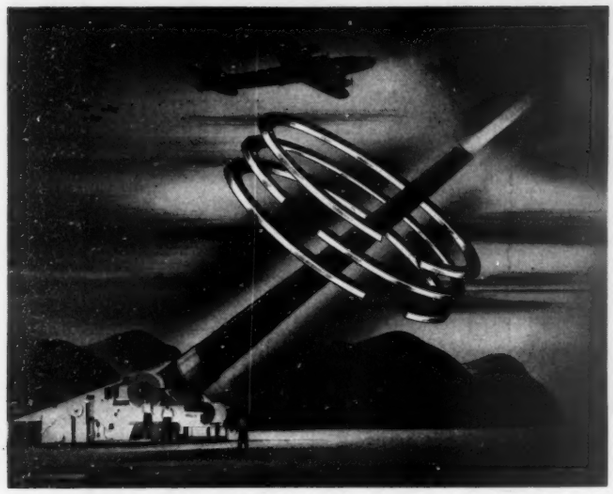

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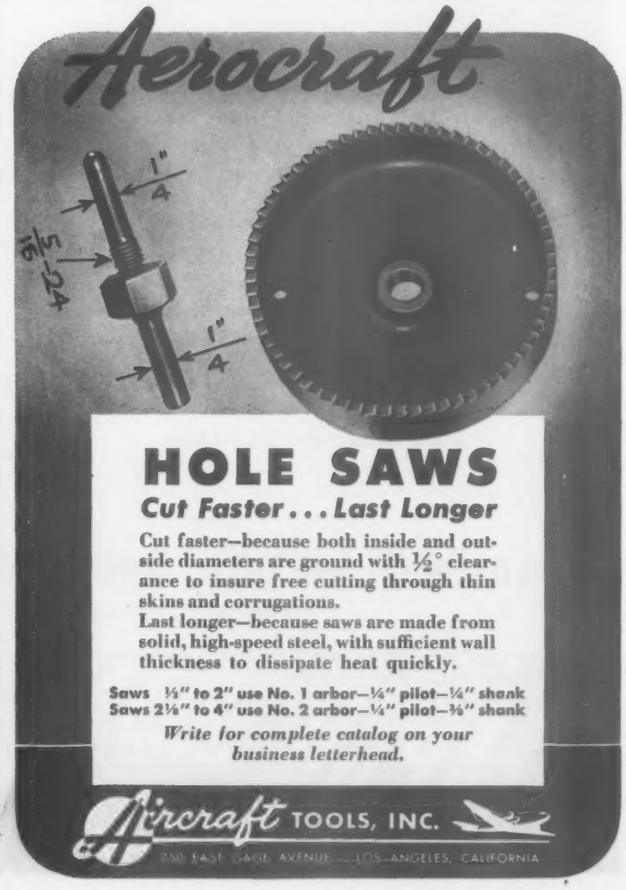

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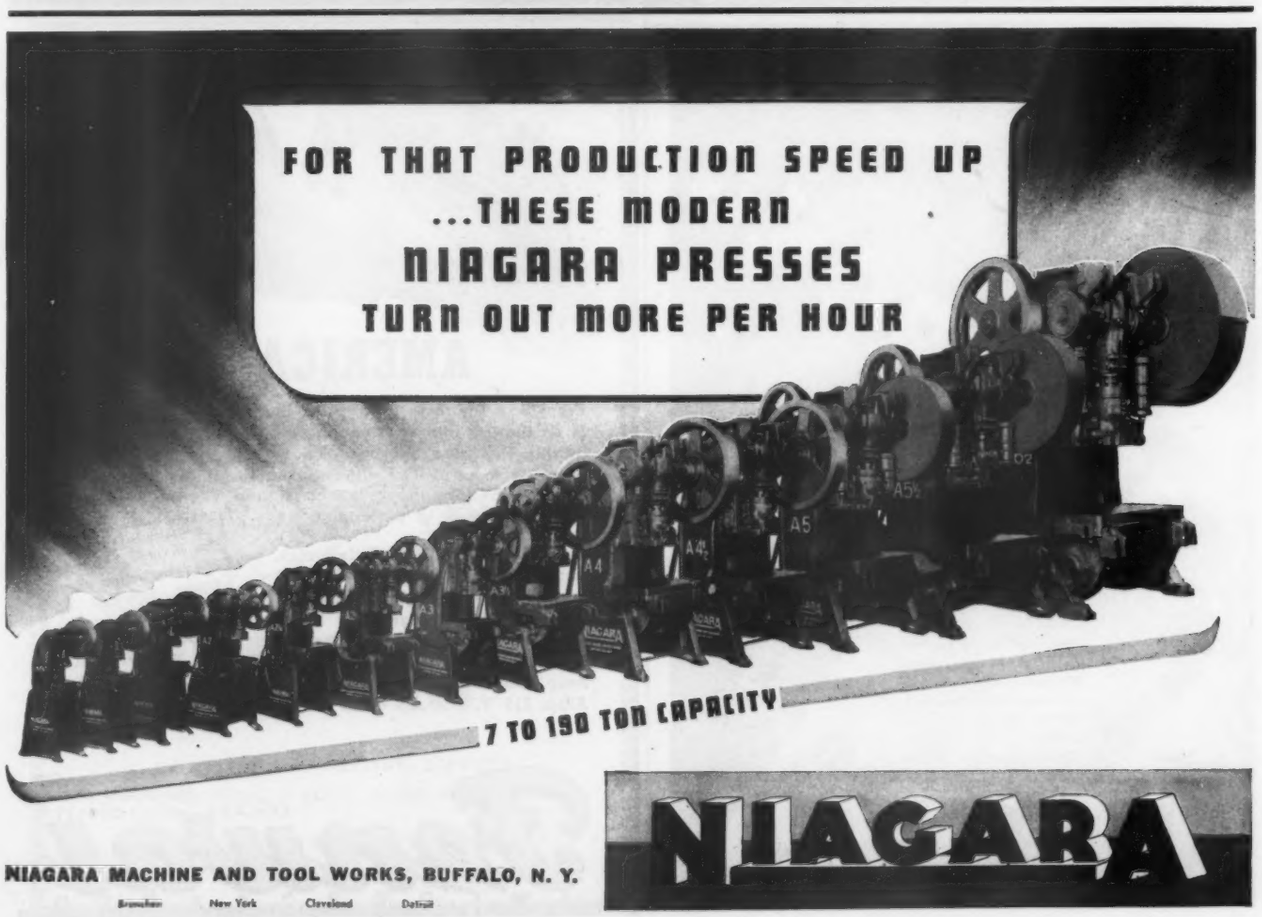
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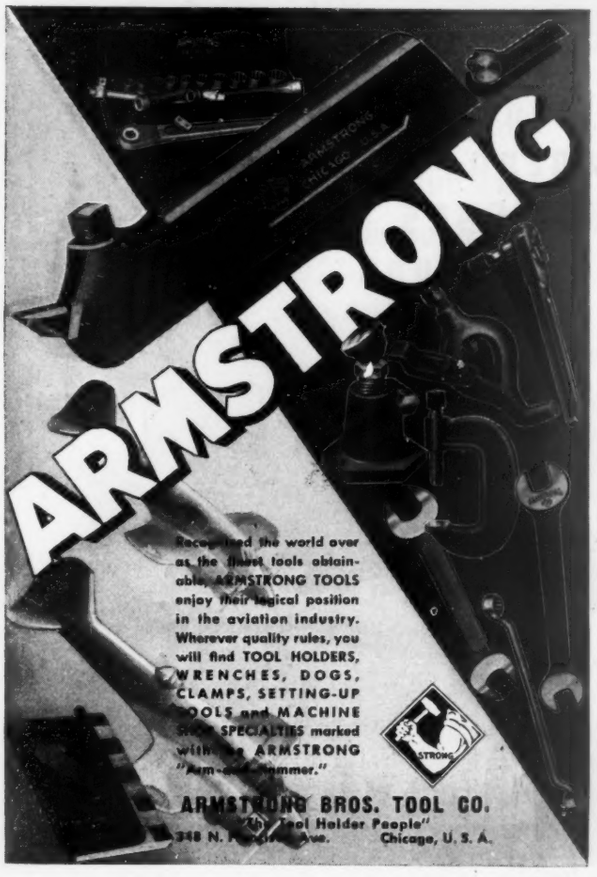
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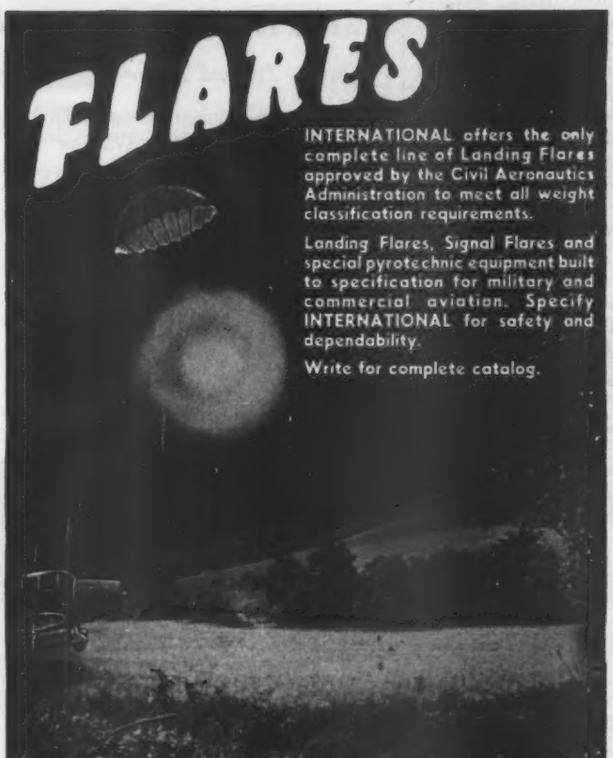

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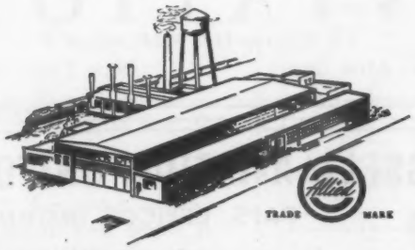

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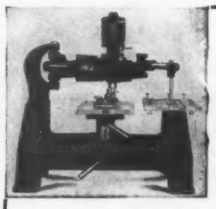

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AVIATION "Classified" — April 1942

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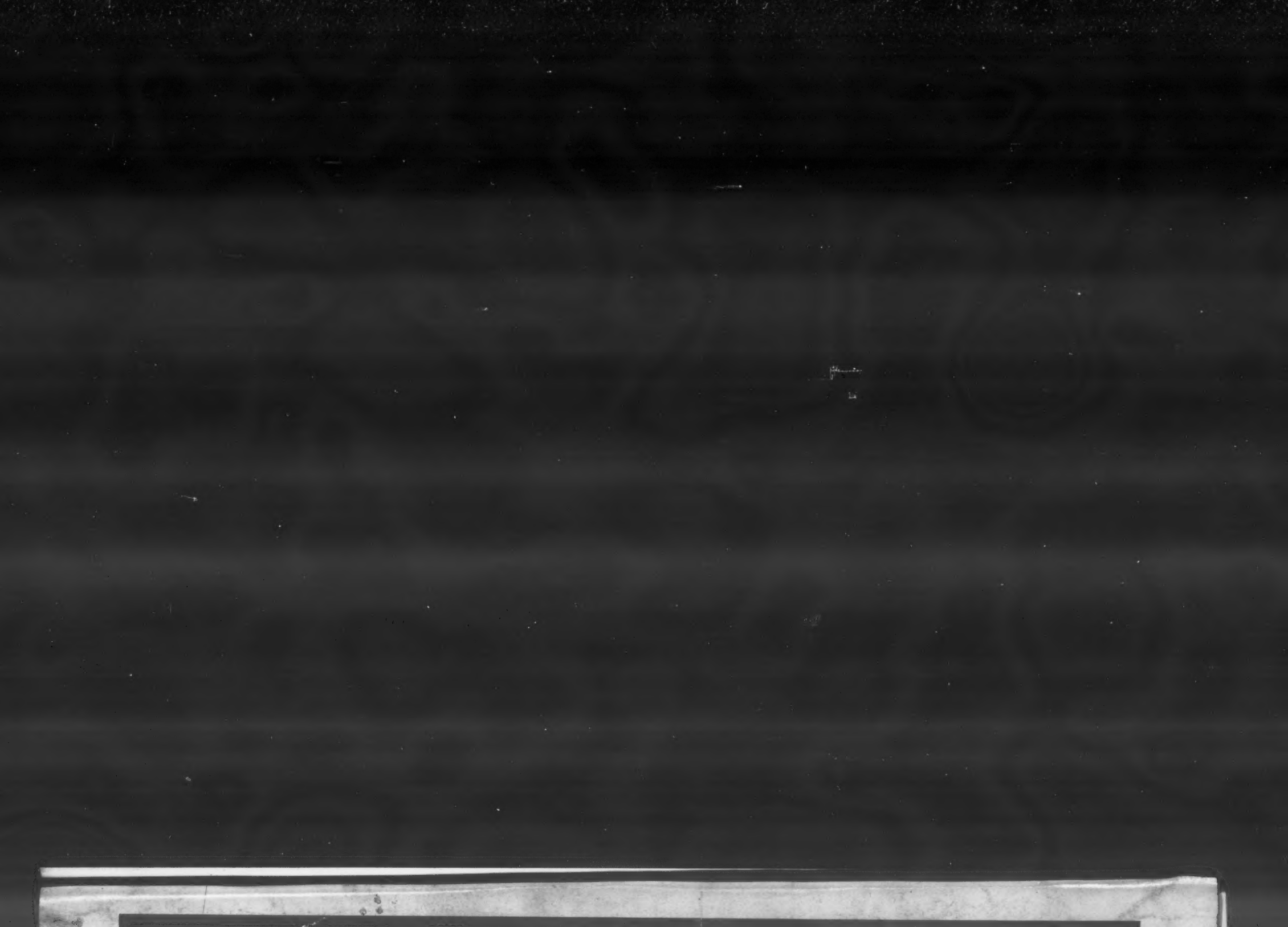
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